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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Acute Coronary Syndrome (ACS) (CPG ID:86)

This CPG provides guidance on best management for ACS patients in deployed and resource constrained environments.

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OVERVIEW

Deployed medical providers at all roles of care must be prepared to recognize and manage Acute Coronary Syndrome (ACS). Under optimal conditions, treatment is initiated with medical therapy and may be followed by prompt coronary angiography and revascularization. Emergent percutaneous coronary intervention (PCI) is not available in most deployed locations however, and the time for such intervention is often dependent on long-range evacuation. This CPG provides guidance on best management for ACS patients in the deployed and resource constrained environment.

BACKGROUND

Coronary heart disease (CHD) is the leading cause of mortality in the U.S. and worldwide.[1,2] Cardiovascular health may in fact be worse for active duty servicemen when compared to the civilian population.[3] Additionally, cardiovascular disease is the second most common chronic disease among active duty Army personnel following arthritis.[4] While clinical CHD typically presents at older ages, significant coronary atherosclerosis and myocardial infarction can manifest in young adults and teenage patients.[5] In a cross-sectional study by Webber et al, coronary atherosclerosis was identified in 8.5% of the autopsies performed on U.S. military personnel in Operation Iraqi Freedom/Operation New Dawn (OIF/OND) and Operation Enduring Freedom (OEF).[6] In this study population, older age, lower educational level, higher body max index at military entrance, and a prior diagnoses of: dyslipidemia, hypertension, and obesity, were associated with a higher prevalence of atherosclerosis. Additionally, myocardial infarction (MI)/ACS was the most common medical/non-surgical diagnosis for Critical Care Air Transport Team (CCATT) evacuations, representing 6.6% of 290 patients evacuated by CCATT during OIF/OEF.[7]

Acute coronary syndrome is typically a consequence of CHD and refers to a spectrum of disease among patients experiencing, or suspected of experiencing, myocardial ischemia.[8] ACS is further divided into three subgroups: 1) ST elevation myocardial infarction (STEMI), 2) non-ST elevation myocardial infarction (NSTEMI), and 3) unstable angina.

When evaluating patients with chest pain concerning ACS, it is important to consider other life-threatening causes of chest pain such as pulmonary emboli, pneumonia, aortic dissection, pneumothorax, esophageal rupture, and myocarditis as they are managed differently. A thorough history and physical exam may be helpful in guiding the deployed provider towards a presumptive diagnosis. When available, imaging, labs, and electrocardiogram (ECG) can further assist in differentiating the etiology of chest pain.[9,10]

Diagnosis and management of ACS can be uniquely challenging in locations where PCI centers or treatment with fibrinolytics are not available. PCI is recommended within 120 minutes of first medical contact and is the preferred and most common treatment for ACS in the U.S..[11] However, if evacuation is required, the delay to reach a PCI center may exceed the recommended door-to-balloon time. Military physicians located Outside Continental United States (OCONUS) may therefore be required to treat ACS with fibrinolytics, which is not common in most U.S. locations. Additionally, many diagnostic tools helpful in evaluating chest pain, such as ECGs and cardiac troponin assays, may not be available in many deployed locations. Refer to Appendix C for ACS management recommendations by role of care.

It is the responsibility of every medical provider to be prepared for initial management of ACS, to include understanding how to use teleconference services. Diagnosis and treatment of ACS should be guided by expert consultation. In addition, the capability to obtain and transmit an ECG and to provide cardiac first aid treatments with oxygen, nitroglycerin and aspirin are key capabilities in initial stabilization and should be available to all deployed medical providers. Expanded capabilities for medical stabilization with anti-platelet agents, systemic anticoagulation and fibrinolytic therapy should be available in the evacuation chain within 24 hours, and must be considered during operational planning. Fibrinolytics are ideally given within 12 hours of symptom onset; however there may be a benefit up to 24 hours after symptom onset.[12,13]

DIAGNOSIS

ACS is a clinical syndrome that includes MI and unstable angina. An MI can present as either a STEMI or NSTEMI. A STEMI typically occurs as a result of plaque rupture and subsequent thrombosis of a coronary artery that leads to infarction and subsequent ECG changes. An NSTEMI does not have the ECG changes seen in STEMI but can also occur secondary to plaque rupture (Type 1 NSTEMI) or to inadequate blood flow to meet the metabolic demands of the myocardium in conditions like sepsis, pulmonary embolism, or coronary vasospasm (Type 2 NSTEMI). In either case, both STEMI and NSTEMI will result in an elevated troponin. Unstable angina is characterized by new onset chest pain, pain lasting greater than 20 minutes or pain at rest or with minimal exertion. While unstable angina can occur with ECG changes not diagnostic of STEMI, it does not have elevated troponins.[10] It is essential to differentiate between STEMI and NSTEMI since those with STEMI require emergent coronary intervention.[9] NSTEMI is more common than STEMI, representing 60-70% of myocardial infarctions.[14] NSTEMI with coronary occlusion is present in 25% of cases.[15]

ACS pain is classically described as exertional, pressure-like chest pain with radiation to the jaw, neck, one or both arms/shoulders, or back. Associated symptoms include nausea/vomiting, shortness of breath, and diaphoresis.[10] Atypical symptoms (dyspnea alone, fatigue, weakness, epigastric pain, palpitations, syncope, nausea alone, and cardiac arrest) are more common in the elderly, women, and diabetics. Atypical symptoms are presented symptoms in one-third of confirmed myocardial infarctions.[16]

Troponin is a protein released from myocardial tissue and is indicative of cardiac cell death. Serum troponin levels begin to rise measurably as early as 2 to 3 hours after onset and can remain elevated for up to 7 days.[10] When available, cardiac troponin assays (cardiac specific I or T) should be used in the diagnosis of MI. A troponin value above the 99th percentile upper reference limit (determined by the assay type) is considered positive. Troponin values may continue to rise, or they may decline depending on the timing of the clinical event, and both situations should raise concern for ACS.[10,17] Due to the time elapsed between cardiac cell death and laboratory detectable rise in troponin levels, the troponin level may be checked serially, usually every 3 to 6 hours.[18]

The following are clinical findings in combination with a rise and/or fall in troponin values that constitute the diagnosis of acute MI:[19]

- Symptoms of ischemia (See above paragraph.)
- New ischemic ECG changes
- Development of pathological Q waves

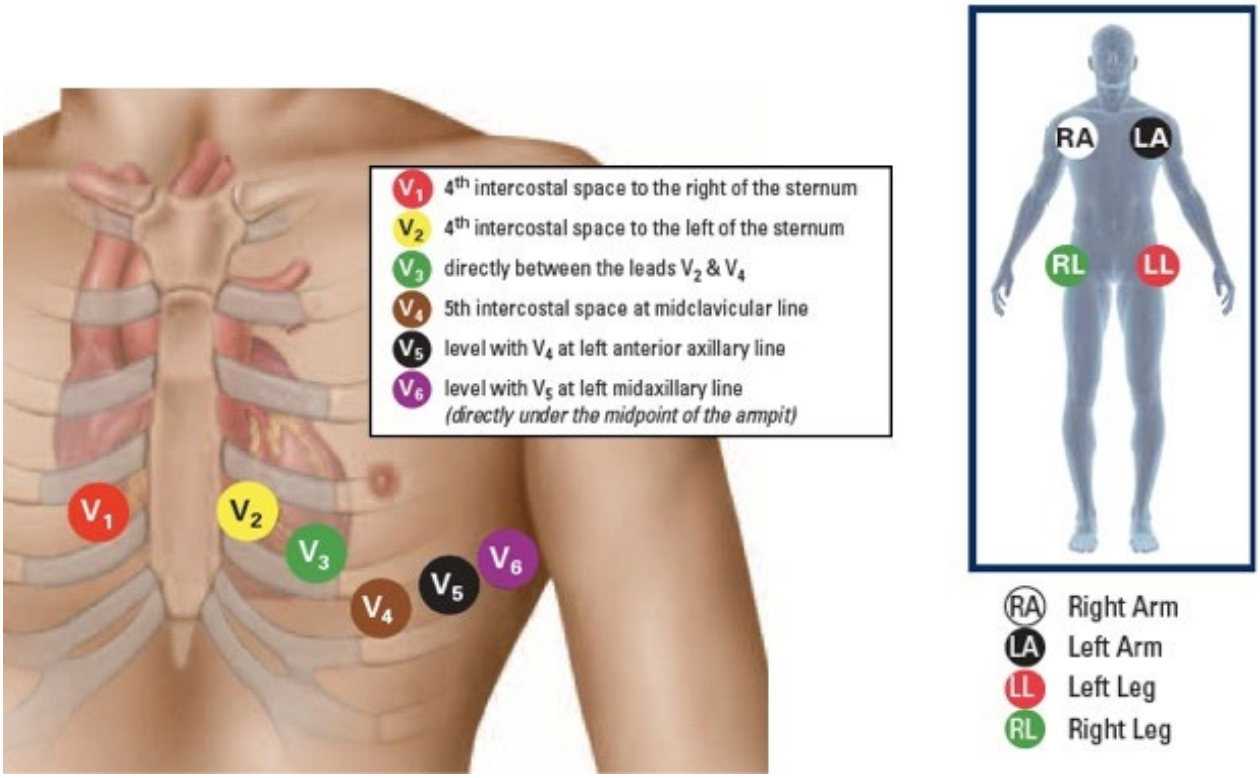
- Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality
- Identification of an intra-coronary thrombus on angiography or autopsy

Other clinical conditions may present with elevated troponin. Some of these conditions may manifest symptoms similar to ACS (myocarditis, pulmonary embolism, and aortic dissection), while other conditions may present without features of ACS (such as rhabdomyolysis, sepsis and renal failure) and their management is distinct from that of ACS.[19] It is therefore important to consider the clinical manifestations and additional studies (ECG, echocardiography) in addition to troponin in the diagnosis of ACS. Keep in mind that in forward deployed locations, laboratory testing for troponin may not be available, and a high index of suspicion must be maintained in the presence of appropriate symptoms.

DIAGNOSIS OF ACS BY ECG CHARACTERISTICS

The 12-lead ECG of STEMI follows an anatomical distribution based on the infarcted artery. ST-elevation in one region should manifest with reciprocal ST-depression in the opposite anatomic region. ST-elevation must be present in two contiguous leads to be diagnostic. Figure 1 shows proper ECG lead placement for a typical 12-lead ECG.

Figure 1. Correct 12-Lead ECG Placement[20]



In conjunction with symptoms consistent with myocardial ischemia, the following are the ECG criteria diagnostics of STEMI:[19]

- New ST-elevations ≥ 0.1 mV in 2 or more contiguous leads except V_2-V_3
- New ST-elevations in V_2-V_3 with the below criteria:
  - ≥ 0.25 mV in men aged < 40 years
  - ≥ 0.2 mV in men aged ≥ 40 years
  - ≥ 0.15 mV in women

Figures 2 - 4 demonstrate typical patterns of anterior, inferior, and lateral wall STEMI, respectively.

Figure 2. 12-Lead ECG Evidence of Anterior STEMI. Notice the ST-elevations in leads I, aVL, and V_1-V_6 with reciprocal ST-depressions in the inferior leads (III and aVF)[21]

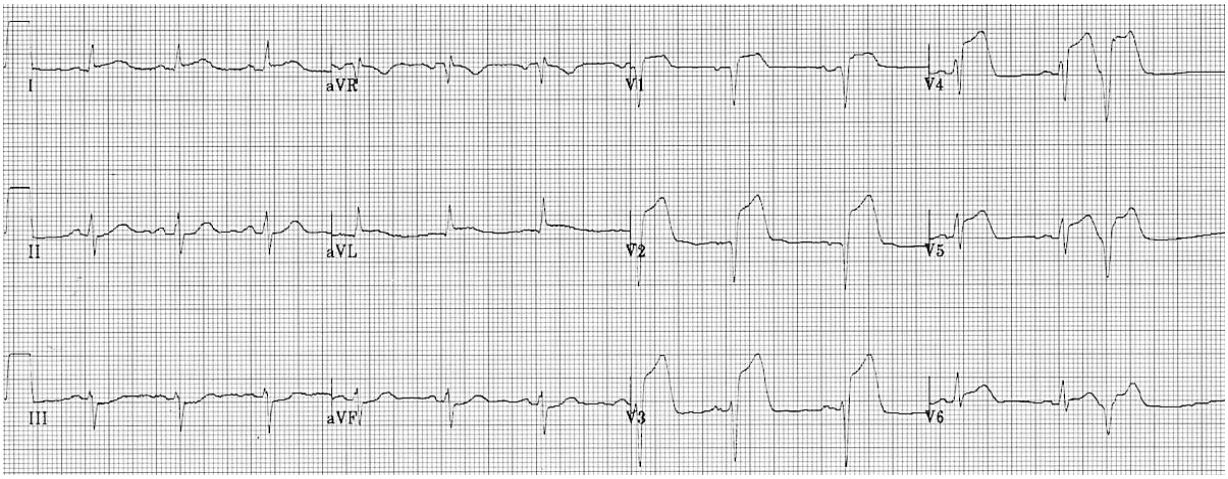


Figure 3. 12-Lead ECG of Inferior STEMI. Notice the ST-elevations in leads II, III, and aVF with reciprocal ST-depressions in antero-lateral leads (I, aVL,V_2, V_3 and V_4)[22]

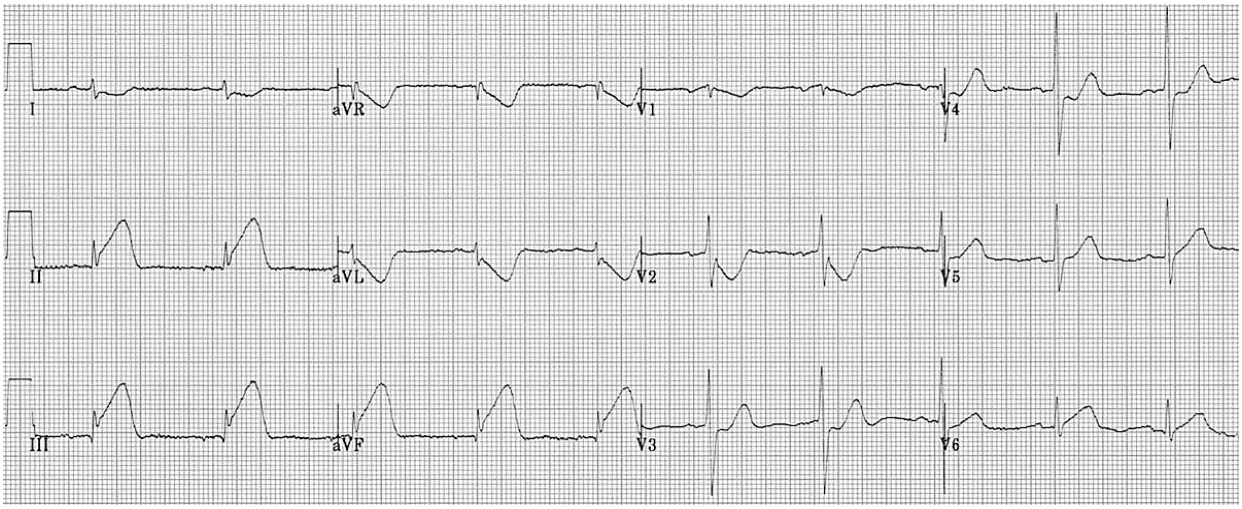
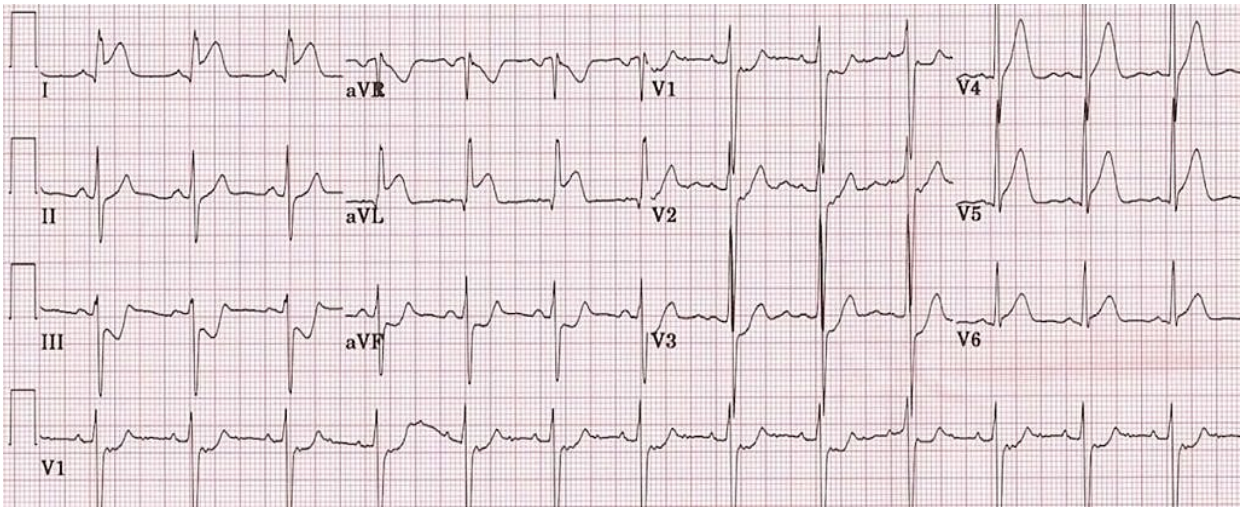


Figure 4. 12-Lead ECG of Lateral STEMI. Notice the ST-elevations in leads I, aVL, V_5, and V_6 with reciprocal ST-depressions in the inferior leads (II, III, and aVF) [23]



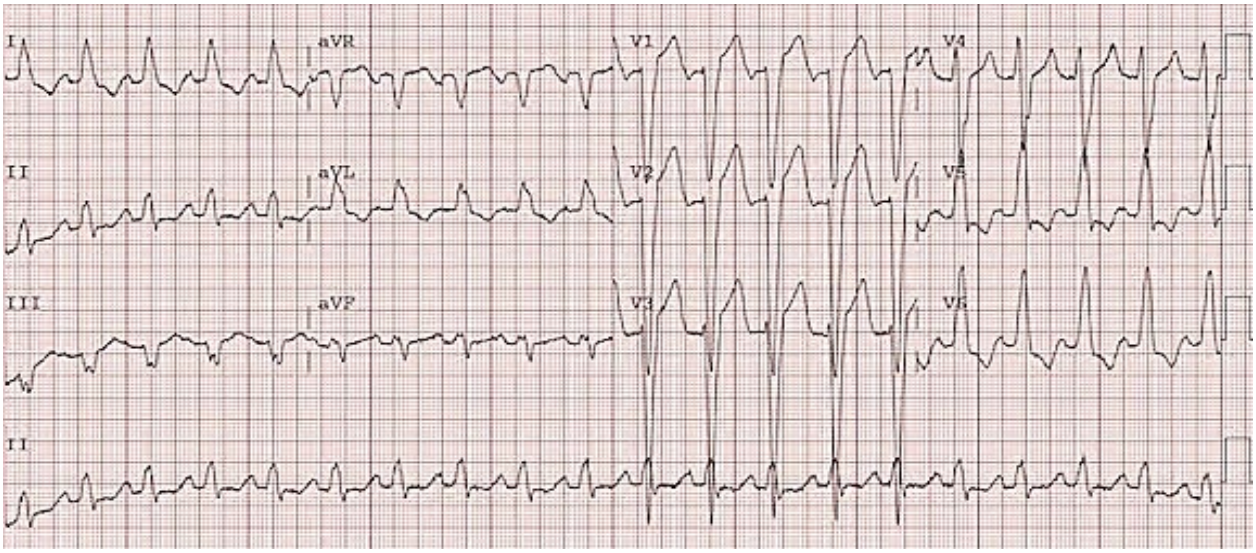
Outside of the standard ECG findings which are diagnostic of a STEMI previously mentioned, there is currently only one universally recognized "STEMI equivalent," which is a left bundle branch block (LBBB) meeting the Sgarbossa's criteria.[19]

There are other highly concerning ECG patterns that include the de Winter pattern, the left main pattern, hyperacute T waves, Wellen's syndrome and posterior MI. These patterns are not considered a STEMI equivalent but emergent/urgent revascularization with PCI that should be considered.[24] ECG interpretation may be complex and urgent teleconsultation with a cardiologist should be considered. ECG changes that should also raise concern for ischemia include ST depressions ≥ 0.5 mm (in ≥ 2 contiguous leads) or T-wave inversion.

1. **LBBB with Sgarbossa's criteria** – Sgarbossa's criteria was developed to identify an acute MI in the setting of a LBBB since this pattern can cause ST- and T-wave changes that make it difficult to identify an MI. The ECG is considered consistent with MI if any of the following three criteria are met and combine to equal ≥ 3 points:[25]
    - ≥ 1 lead with ≥ 1 mm of concordant ST-elevation with the QRS complex (5 points)
    - ≥ 1 lead of V_1-V_3 with ≥ 1 mm of concordant ST-depression with the QRS complex (3 points)
    - ST- elevation of ≥ 5 mm that is discordant with the QRS complex (2 points)
2. **Modified Sgarbossa criteria** (listed below) may outperform the original proposed criteria.[26] Any of the changes listed below are diagnostic of MI in the modified criteria.
    - ≥ 1 lead with ≥ 1 mm of concordant ST elevation with QRS
    - ≥ 1 lead of V1-V3 with ≥ 1 mm of concordant ST depression with QRS
    - ≥ 1 lead anywhere with ≥ 1 mm ST-elevation and proportionally excessive discordant ST-elevation, as defined by ≥ 25% of the depth of the preceding S-wave (an ST:S ratio of ≤ -0.25)

Figure 5. 12-Lead ECG of STEMI using the modified Sgarbossa' s criteria

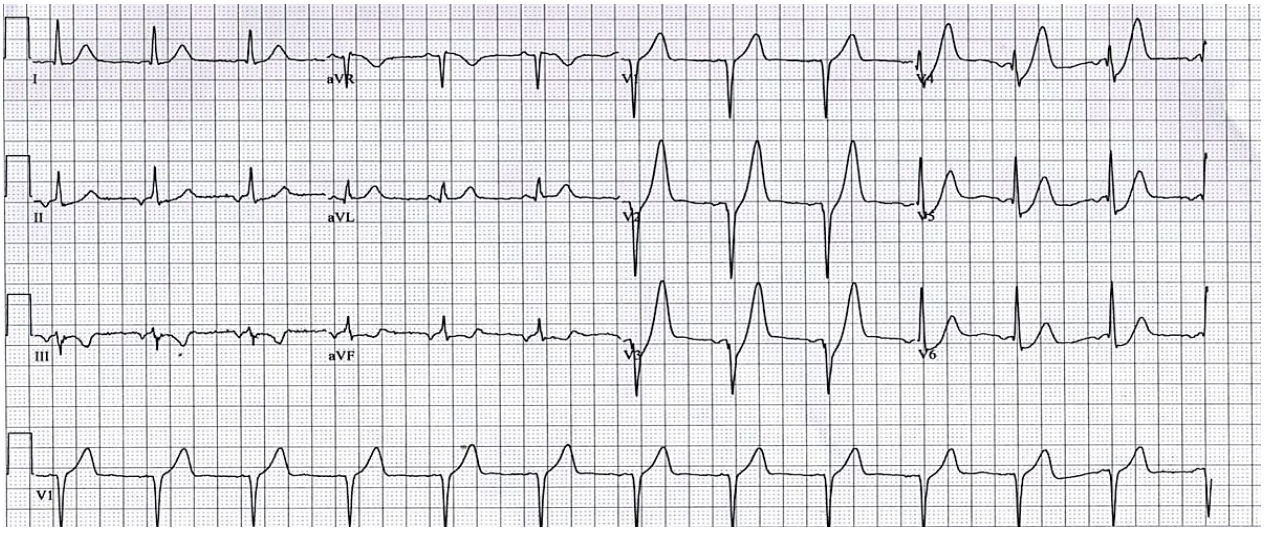
https://epmonthly.com/article/stemi-in-the-presence-of-lbbb/



ECG Patterns Highly Concerning for Myocardial Infarction

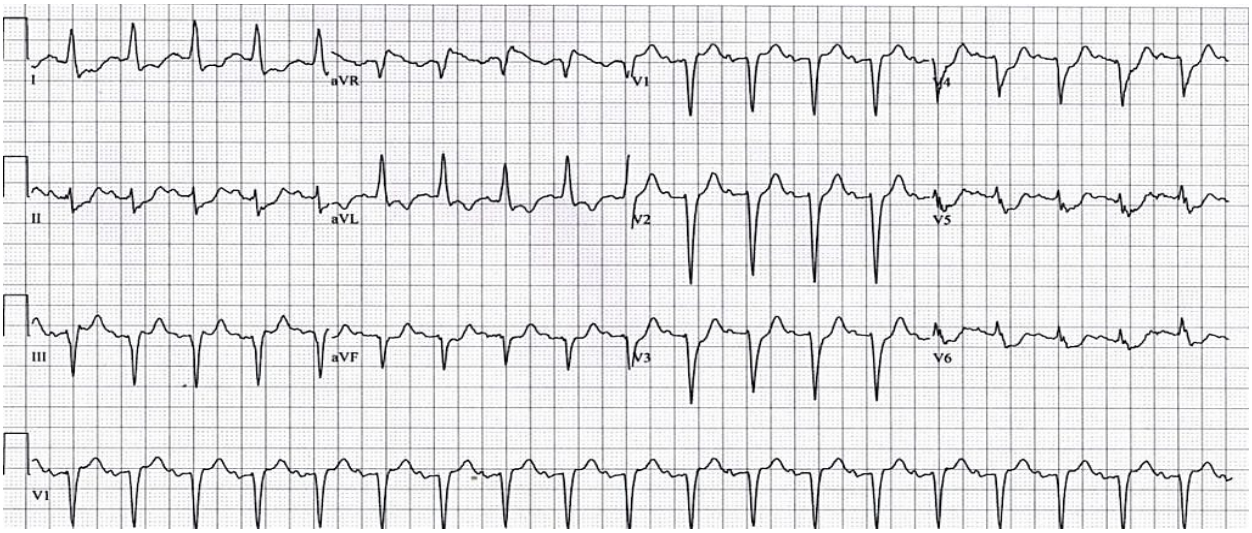
1. **De Winter pattern** – ST-depressions at the J point in V_1-V_6 and tall, peaked, symmetric T-waves are consistent with a de Winter pattern and associated with proximal left anterior descending artery (LAD) occlusion.

Figure 6. 12-Lead ECG of STEMI with De Winter pattern[27]



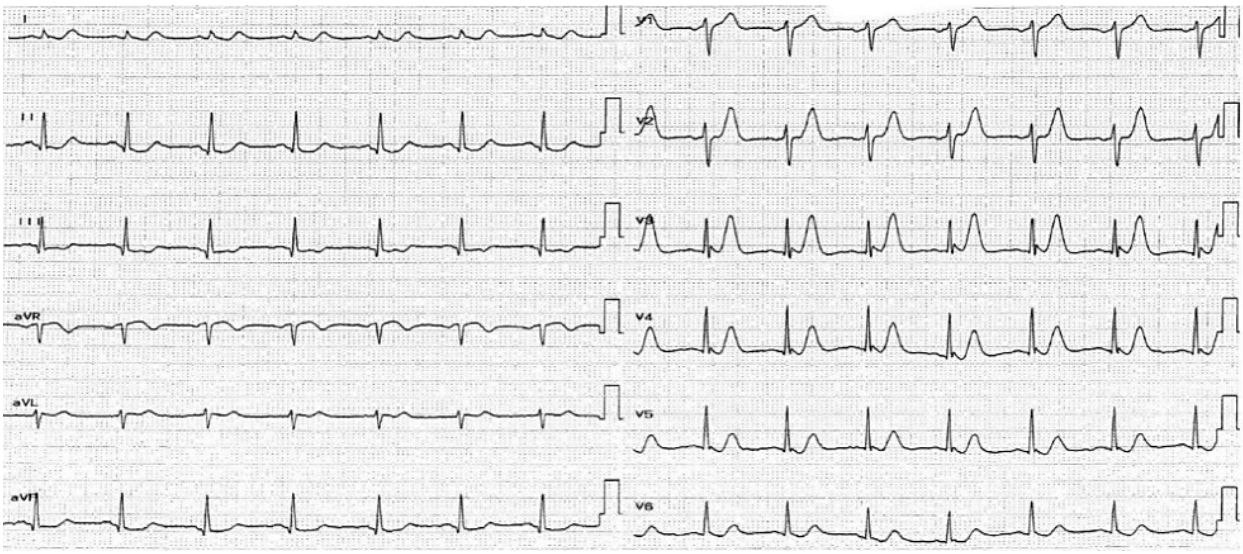
2. **Left main pattern** - Multi-lead ST-depression with coexistent ST-elevation in lead aVR has been described in patients with left main artery or proximal LAD occlusion. This is referred to as a left main pattern.

Figure 7. 12-Lead ECG of STEMI with left main pattern[28]



3. **Hyperacute T waves** – broad, asymmetrically peaked T-waves can be seen in early STEMI.

Figure 8. 12-lead ECG of STEMI with hyperacute T-waves[29]



4. **Wellen's syndrome** – Biphasic T-waves (Type A) or deep, symmetric T-wave inversions (Type B) in leads V_2-V_3 are strongly associated with proximal LAD occlusion. This is referred to as Wellen's syndrome.

Figure 9. 12-Lead ECG of STEMI with biphasic T-waves indicative of Wellen's syndrome[30]

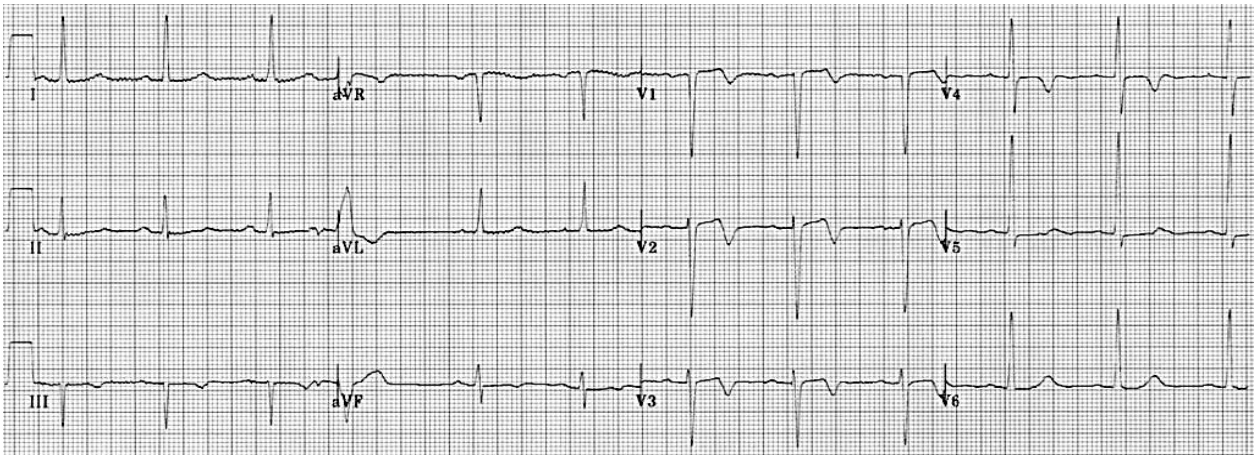
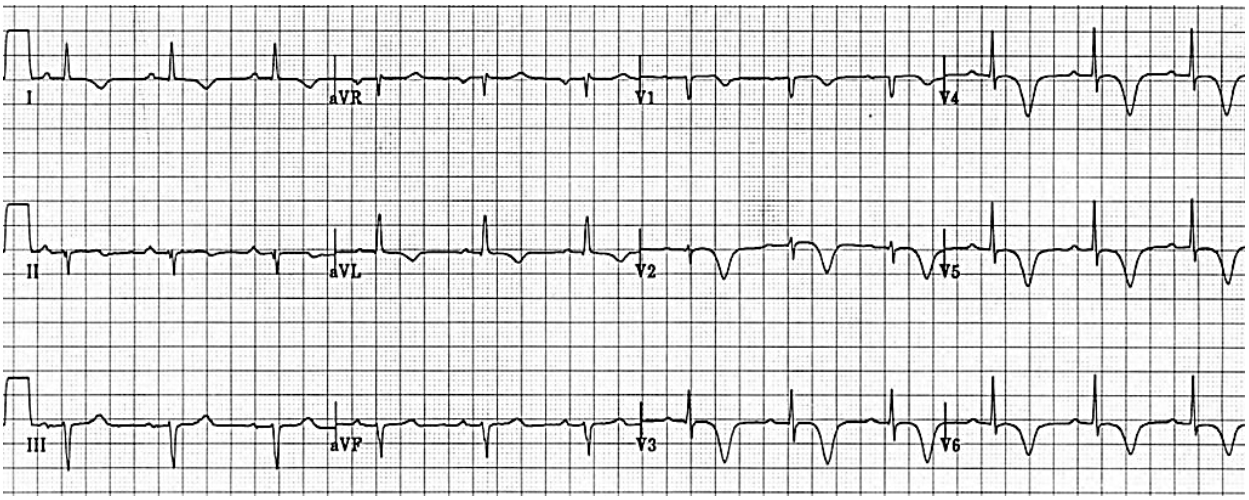


Figure 10. 12-lead ECG of STEMI with deep, symmetrical T-wave inversions indicative of Wellen's syndrome[30]



Another indication of acute cardiac ischemia on the ECG is flat or down-sloping ST-depression ≥ 0.5 mm in 2 contiguous leads (Figure 11). If the ST-depressions are seen in leads V_1-V_3 then the next step should be to obtain a 12-lead ECG with posterior leads. This is accomplished by removing leads V_4-V_6 from the patient and placing them at the inferior margin of the left scapula, as shown in Figure 12. If these leads (now called V_7-V_9) show ST-elevation this will be consistent with a posterior STEMI (Figure 13).

Figure 11. 12-lead ECG showing ST-depressions in V_2-V_3 which is suspicious for posterior STEMI[31]

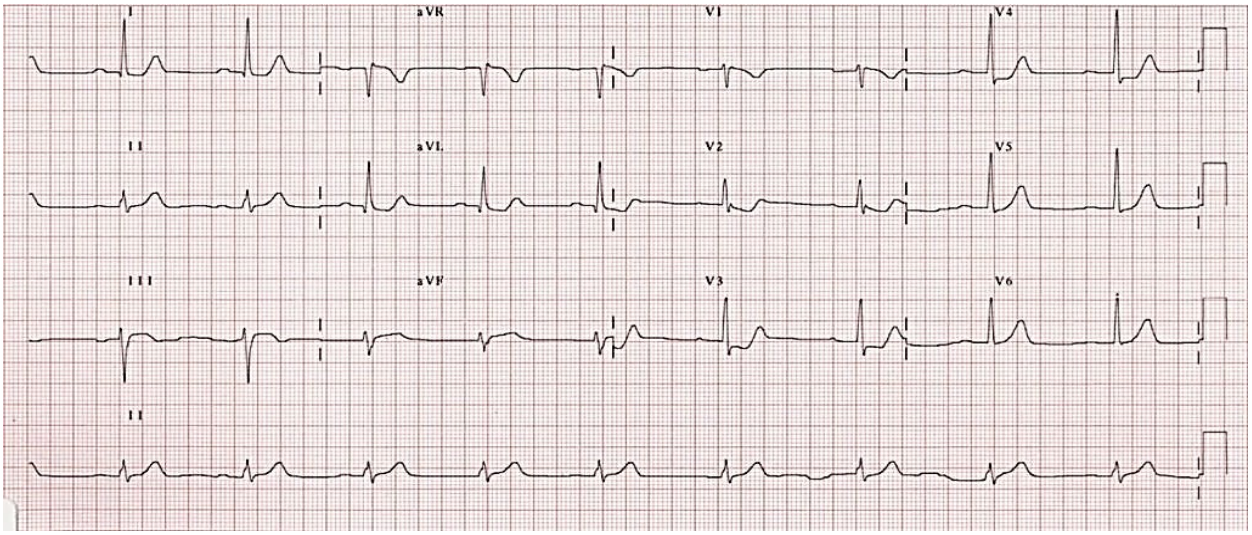


Figure 12. Posterior ECG lead placement[32]

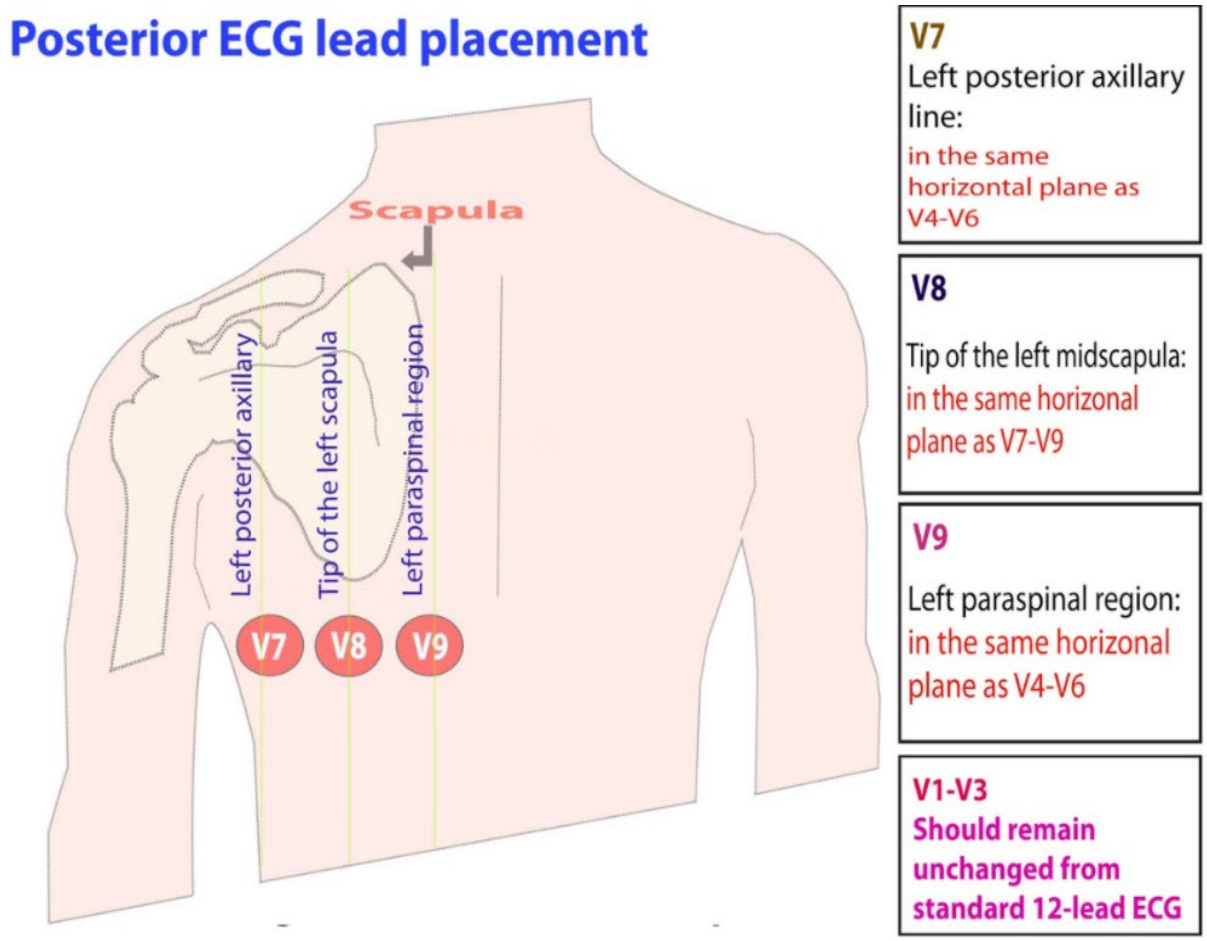
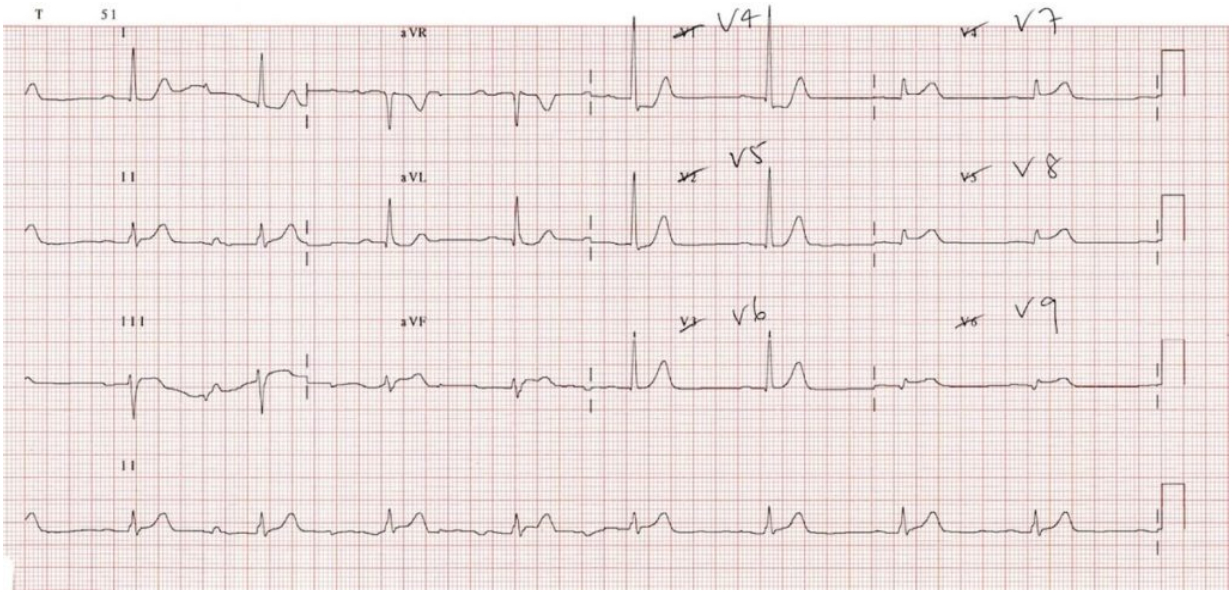
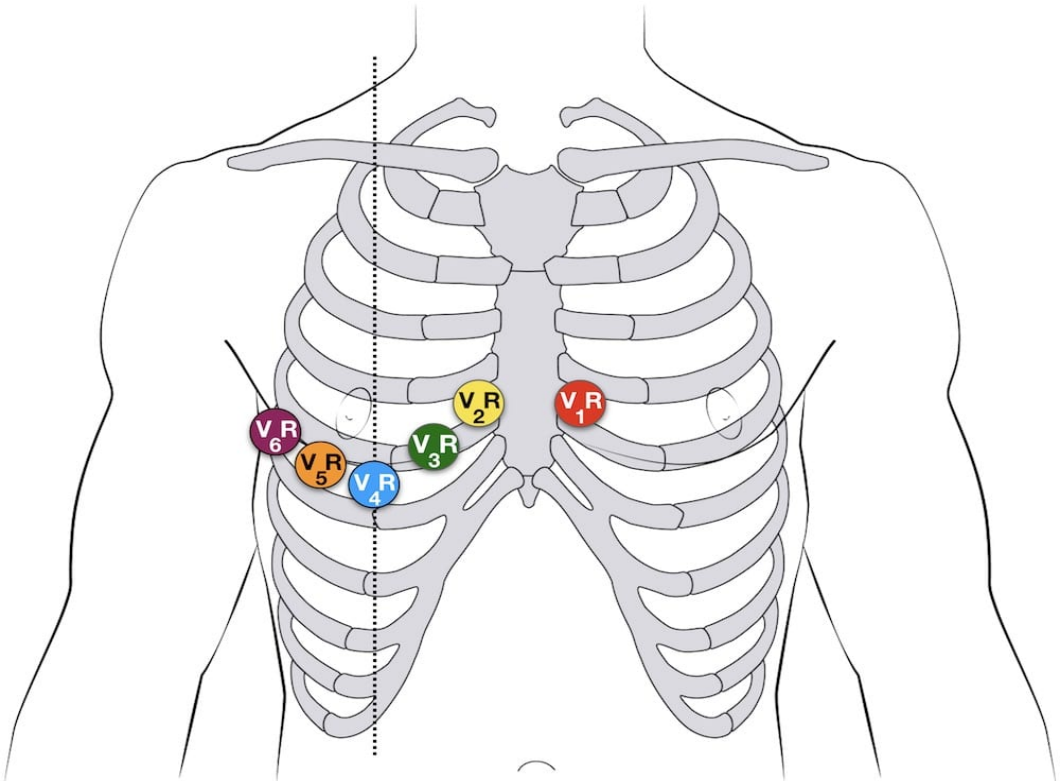


Figure 13. 12-lead ECG STEMI Showing posterior STEMI. Notice ST-elevations in posterior leads V_7-V_9[31]



Similarly, if the initial ECG shows evidence of an inferior STEMI (ST-elevation in lead II, lead III, and aVF with reciprocal changes), then consider placing leads V_1-V_6 on the patient as a complete mirror reflection (as shown in Figure 14). If these leads (now called V_1R-V_6R) show ST-elevation this will be consistent with right ventricular infarction.

Figure 14. Right-sided ECG lead placement[33]



If the initial ECG is non-diagnostic (i.e. only one lead meeting ST-elevation criteria but the second contiguous lead ST-elevation is less than 0.1 mV) but the suspicion for ACS is present, then serial ECGs (every 15 minutes for the first hour) should be performed to ensure STEMI is not missed.[17,19]

In contrast to STEMI, UA/NSTEMI can present with a myriad of ECG findings. These may include normal ECGs, nonspecific T-wave inversions, ST-depression or transient ST-elevation.

TREATMENT

MEDICAL THERAPY

Initial medical therapy for ACS includes rapid delivery of antiplatelet agents, anticoagulants and revascularization therapy to include fibrinolytic therapy (if no contraindications exist and PCI is not immediately available). The below sections include lists of common available medications in each class.

Antiplatelet Therapy

Aspirin should be administered immediately to all patients with suspected ACS if no contraindications exist. Once the diagnosis of ACS has been made, a platelet adenosine diphosphate receptor (P2Y).[12] An inhibitor (e.g., clopidogrel, ticagrelor) should then also be administered if no contraindications exist. Initial dosing for all agents is listed below.

1. **Aspirin 162** – 325mg PO x 1 (chewable is preferred, non-enteric coated preferred if chewable not available) then 81mg PO daily.

AND

2. **Clopidogrel (Plavix)**
    a. Age ≤ 75 years old: initial loading dose of 300mg PO x 1 then 75mg PO daily.
    b. Age > 75 years old: initial dose of 75mg PO x 1 then 75mg PO daily.

OR

3. **Ticagrelor (Brilinta)** 180mg PO x1 then 90mg twice daily.
    It is important to note that ticagrelor can cause dyspnea which is thought to be benign, though sometimes concerning to the patient/clinician.

Anticoagulant Therapy

Systemic anticoagulation should be administered as soon as the diagnosis of ACS is made if no contraindications exist. Options for anticoagulants include unfractionated heparin and low molecular weight heparin (LMWH) (i.e. enoxaparin) which exert their anticoagulant properties by indirectly inhibiting thrombin. Another option is factor Xa inhibitor (i.e. fondaparinux). Heparin is administered as a bolus followed by a drip, and its effects are monitored by the activated partial thromboplastin time (aPTT). Currently, typical CCATT that transports patients out of theater do not have the ability to monitor aPTT for heparin drips. Thus, enoxaparin is preferred over a heparin drip when transport is required, given its ease of use. If enoxaparin or another LMWH is not available, then consideration of fondaparinux should be utilized if available. If heparin is the only agent available, then it should be given. Dosing consideration for transport would be decided based on an aPTT immediately prior to the

flight. For patients that have a known or suspected history of heparin induced thrombocytopenia, fondaparinux should be used. Anticoagulation should continue for at least 48 hours or until revascularization.

The following are the dosing for each agent listed below:

1. **Enoxaparin (Lovenox) – *preferred agent***
    a. **STEMI dosing:**
        - Age < 75 years: single 30mg IV bolus **plus** 1mg/kg SubQ (maximum 100mg for the first 2 doses only). then 1mg/kg SubQ every 12 hours
        - Age ≥ 75 years: 0.75 mg/kg SubQ every 12 hours
    b. **NSTEMI dosing**: 1mg/kg SubQ every 12 hours.
    c. Consult pharmacy to adjust this dose if there is any renal injury (rise in creatinine).

OR

2. **Heparin Sulfate**
    a. **STEMI dosing**: 60 U/kg initial bolus IV (4,000 U maximum), then 12 U/kg/hr (maximum 1,000 u/hr) infusion.
    Maintain aPTT 1.5–2.0 times control (50-70s).
    b. **NSTEMI dosing**: 60 U/kg initial bolus IV (5,000 U maximum), then 12 U/kg/hr (maximum 1,000 U/hr) infusion.
    Maintain aPTT 1.5–2.0 times control (50-70s).

OR

3. **Fondaparinux (Arixtra)**
    a. **STEMI dosing**: 2.5 mg IV x1 then 2.5 mg SubQ daily.
    b. **NSTEMI dosing**: 2.5 mg SubQ daily.

REPERFUSION THERAPY

Prompt reperfusion is the mainstay of STEMI care. Whenever possible, a patient presenting with STEMI should be transferred emergently to the nearest medical facility that can perform urgent PCI as it is considered the optimal treatment. This should be achieved within 2 hours of patient arrival.[13] In the event that door-to-balloon time cannot be achieved within 2 hours, fibrinolytics should be given instead. In the deployed setting, PCI, may be prohibitively far away, and thus rapid delivery of fibrinolytic therapy is the method of choice for revascularization. Fibrinolytic therapy should be administered within 30 minutes of STEMI diagnosis. There are absolute and relative contraindications to administration of fibrinolytics (listed in Appendix A). This list should be meticulously reviewed step by step prior to administration of these agents. The two most common agents available are listed below with their dosing. Fibrinolytics should be offered to patients with symptom duration of 12 hours or less. It is recommended that expert consultation with the theater cardiology consultant be used prior to administering fibrinolytics in the 12 to 24 hour period.

***Note**: Dual antiplatelet therapy, systemic anticoagulation, beta blocker and high dose statins should still be given even when fibrinolytics are given.*

1. **Tenecteplase (TNKase) – *preferred agent***
   a. < 60 kg: 30mg IV bolus x 1
   b. 60-69 kg: 35mg IV bolus x 1
   c. 70-79 kg: 40mg IV bolus x 1
   d. 80-89 kg: 45mg IV bolus x 1
   e. ≥ 90 kg: 50mg IV bolus x 1

OR

2. **Alteplase (Activase)**
   a. ≤ 67 kg: 15mg IV bolus over 1-2 minutes, then infusion of 0.75 mg/kg (maximum 50mg) over 30 minutes, then infusion of 0.5 mg/kg (maximum 35mg) over 60 minutes.
   b. 67 KG: 15mg IV bolus over 1-2 minutes, then infusion of 50mg over 30 minutes, then infusion of 35mg over 60 minutes (maximum total dose 100mg).

NOTE: In contrast to STEMI, fibrinolytics are contraindicated in UA/NSTEMI patients.

STATIN THERAPY

Regardless of the patient's blood lipid levels, high dose Statin therapy should also be administered during the initial presentation (within the first 2 hours) of ACS. The following are the two therapy options to administer:

1. **Atorvastatin (Lipitor)** 80mg PO x 1 then 80mg nightly.

OR

2. **Rosuvastatin (Crestor)** 20-40mg PO x1 then 20-40mg PO daily.

SUPPORTIVE THERAPY

Supplemental Oxygen

Administer ring oxygen in patients with ACS is recommended only when oxygen saturation levels are < 90%, to avoid potential harm from oxygen free radicals and further hyperoxia coronary vasoconstriction.

Analgesia

Decreasing the pain response can block sympathetic activity and relieve anxiety, which decreases myocardial oxygen consumption. The routine use of morphine for pain control is not recommended since this has been shown to increase the risk of mortality in ACS.[34] Nitroglycerin a vasodilator, opens blood vessels to improve blood flow; treating angina symptoms, such as chest pain or pressure that

happens when there is not enough blood flowing to the heart. Nitroglycerin dilates coronary arteries and relaxes vascular smooth muscles, resulting in decreased preload/afterload and decreased myocardial oxygen demand.

Nitroglycerin

1. Initial dose of 0.3 – 0.4 mg sublingually every 5 minutes for 3 doses; afterwards an intravenous infusion may be considered.
2. If a nitroglycerin IV infusion is administered, start at 5-10 mcg/ minute (min) and titrate as needed to relieve anginal symptoms in increments of 5 mcg/min every 5-10 minutes up to 20 mcg/min; if angina persists at a dose of 20 mcg/min then increase the dosage by 10-20 mcg/min every 3-5 minutes to a maximum dose of 400 mcg/min.
3. Nitroglycerin is contraindicated in patients who have a systolic blood pressure < 100 mmHg, who have used phosphodiesterase inhibitors in the last 24 hours, or who have evidence of inferior STEMI on ECG.

Beta Blockers

Beta blockers block sympathetic stimulation and decrease the heart rate. They have been shown to decrease early development of lethal ventricular dysrhythmias as well as improve long term left ventricular remodeling. Although the American Heart Association and American College of Cardiology recommend that beta blockers be initiated in the first 24 hours of NSTEMI, there have been studies that show early administration of beta blockers in the ED was associated with higher rates of shock or death than later administration.[35] Initiate this medication after the patient has been hospitalized in either the Role 2 or Role 3. Beta blockers should be withheld in patients with systolic blood pressure < 100 mmHg, heart rate < 60 beats per minute, evidence of pulmonary edema, second or third degree heart block, severe reactive airway disease, or elevated risk of cardiogenic shock.

1. **Metoprolol tartrate** (immediate release) – 12.5 mg PO every 6 – 12 hours.

OR

2. **Metoprolol succinate** (extended release) – 25-50 mg PO once daily.

OR

3. **Atenolo**l – 50-100 mg PO every 12 to 24 hours.

ACE Inhibitors and ARBs

Angiotension converting enzyme (ACE) inhibitors that are initiated within 24 hours to 16 days after an acute MI show improved patient survival as well as improved left ventricular ejection fraction. ACE inhibitors are contraindicated in systolic blood pressure < 100 mmHg, history of bilateral renal artery stenosis, hyperkalemia, or prior worsening renal function with ACE inhibitors. It is reasonable to administer angiotensin receptor blockers (ARBs) in patients who cannot tolerate ACE inhibitors.

1. **Captopril** - initial dose of 6.25 mg PO, which is increased at 6 to 8 hour intervals to a maximum of 50 mg PO three times daily as long as the systolic blood pressure is above 90 to 100 mmHg.

OR

2. **Enalapril** - initial dose 2.5 mg PO daily increased up to 20 mg PO twice daily.

OR

3. **Lisinopril** - initial dose 2.5 mg PO daily increased to a maximum of 10 mg PO daily.

OR

4. **Losartan** - 25 to 50 mg PO once daily depending on initial blood pressure.

Other Therapies

If indicated continue to utilize Proton pump inhibitors. Nonsteroidal anti-inflammatory drugs (NSAIDs) on the other hand should be avoided in these patients due to their increased risk of adverse cardiovascular events and the increased risk of bleeding when combined with the other mainstay treatments of ACS such as antiplatelet and anticoagulant therapy. Routine use of blood transfusion in the setting of ACS is associated with increased mortality.[13,36,37] It is recommended to avoid transfusion unless the hemoglobin level is < 8 g/DL .

COMPLICATIONS TO THERAPY

BLEEDING COMPLICATIONS

Bleeding complications are likely to be rare but they may be encountered and should be closely watched. Neurological checks should occur every 15 minutes for the first hour and then 30 minutes for the next 6 hours to monitor for intracranial bleeding. Normotension should be strived for while SBP > 160 mmHg should be avoided. Once life-threatening bleeding is identified, stop all antiplatelet agents, anticoagulants, and fibrinolytics. Specific reversal therapies unique to life-threatening bleeding due to thrombolysis are listed below.[38] In the case of suspected intracranial bleeding, obtain an emergent CT head and consult neurosurgery if an intracranial bleed is actually present.

1. Administer Cryoprecipitate - 10 units IV.
2. Administer tranexamic acid (TXA) – 10-15 mg/kg IV.
3. Stop all antiplatelet, anticoagulant, and fibrinolytics.

COMPLICATIONS ASSOCIATED WITH MI

There are both early and late complications associated with MI. Early complications will be the focus here as these are the ones likely to be seen in the deployed setting during the initial hours to days of treatment.

CARDIOGENIC SHOCK

Cardiogenic shock is best defined as SBP < 90 mmHg for 30 minutes or SBP > 90 mmHg on vasopressors with evidence of end organ damage from a cardiovascular origin. The patient may have evidence of pulmonary edema (worsening dyspnea, crackles, worsening chest x-ray) or evidence of peripheral hypoperfusion (weak pulses, cold extremities). Listed below are the vasopressor/inotropic agents that should be utilized in this situation.[39]

1. **Norepinephrine** (preferred first line agent) - 5 – 20 mcg/min IV. Start at 5 mcg/min and increase by 2-5 mcg/min q15 minutes.
2. **Dopamine** - 0.5 to 20 mcg/kg/minute IV (lower doses preferred).

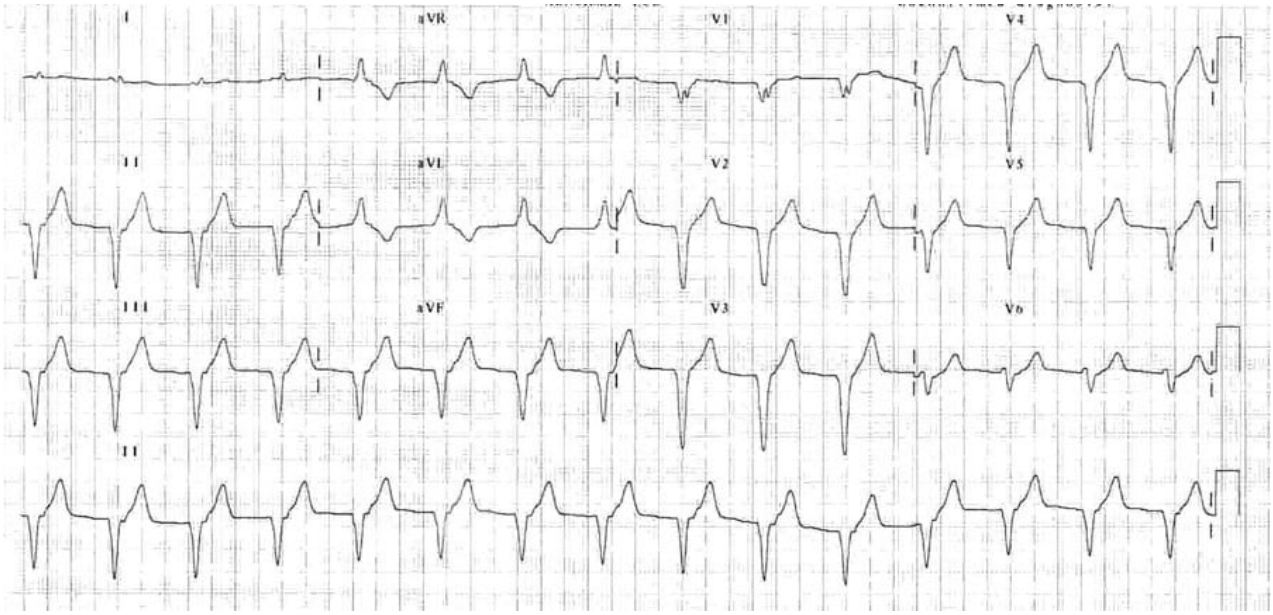
MECHANICAL COMPLICATIONS

Mechanical complications primarily manifest as either acute chordal rupture of the mitral valve, ventricular septal rupture, or left ventricular free wall rupture. These typically occur within the first 24 hours but can present within a week as well. The use of fibrinolytics is also a risk factor for an acute ventricular septal rupture and left ventricular free wall rupture. Medical therapy is only temporary with a high mortality rate for those unable to undergo surgical correction. Echocardiography is the modality of choice for rapid diagnosis. This can show pericardial effusion when associated with left ventricular free wall rupture.

ARRHYTHMIAS

There are multiple different tachy- and brady-dysrhythmias that can occur with acute MI. Most can be addressed using ACLS protocols. The most common rhythm following reperfusion is accelerated idioventricular rhythm (Figure 14). This manifests as a wide complex QRS rhythm (as you would see with ventricular tachycardia) with heart rates in the 50 – 110 bpm; it is benign and requires no intervention.[40] Patients are typically asymptomatic with normal vital signs otherwise, and it should resolve spontaneously.

Figure 15. 12-lead ECG STEMI Accelerated idioventricular rhythm after STEMI reperfusion[40]



CONSIDERATIONS DURING MECHANICAL VENTILATION

MEDICATIONS

If the patient with ACS begins to develop shock and is unable to protect his/her airway, then you might have to perform endotracheal intubation (Refer to Airway Management CPG). The following considerations should be made regarding induction and post-intubation sedation medications:[41]

1. **Ketamine** should be avoided in patients with acute MI or heart failure due to increased myocardial oxygen consumption and negative inotropic effects.
2. **Etomidate** is recommended for induction of anesthesia given its neutral effects on hemodynamics.
3. **Propofol** should be used with caution in induction, given its ability to cause acute hypotension. It is generally safe for maintenance of anesthesia, however, caution should be used in patients with severe cardiac disease as propofol has also been shown to exacerbate cardiac dysfunction through its negative inotropic effects.
4. **Versed/Fentanyl** is acceptable for induction/maintenance of anesthesia.

VENTILATOR SETTINGS

High intrathoracic pressures affect the right and left ventricles differently. High intrathoracic pressures impair right ventricular filling, yet reduces left ventricular afterload. In a patient's post-MI that require mechanical ventilation, minimization of intrathoracic pressures for a patient with inferior/right ventricular infarction is essential to maintain cardiac output. PEEP and tidal volume should be minimized as much as possible.

CONSIDERATIONS DURING EVACUATION

The care of ACS patients at deployed locations is limited by the fact that cardiac care is provided in austere locations without rapid access to higher levels of care. While medical therapies can stabilize patients for short periods of time, any complications that arise do not have the benefit of being treated urgent/emergently in a cardiac catheterization laboratory. A plan for urgent MEDEVAC/aeromedical evacuation to a PCI capable center should be initiated as soon as they are diagnosed with ACS and initiated medical therapy.

TELEMEDICINE/CARDIOLOGY CONSULTANT

The first cardiology consultant within the evacuation chain should be consulted immediately for patients diagnosed with a STEMI or UA/NSTEMI at deployed locations. Diagnosis and treatment of ACS should be guided by expert consultation, to include electronic transmission of ECGs (by whatever means available).

MEDEVAC

When possible, all patients diagnosed with or with high suspicion of ACS at Role 1 or 2 facilities should be moved to a Role 3 facility (preferably a facility with a cardiologist) as soon as possible.

HOST NATION

At times host nations (HNs) have facilities that meet U.S. standards for medical care. If relationships with these facilities have been established and have been utilized for emergent care of U.S. personnel, then their use should be considered for emergent PCI in the following situations:

1. **STEMI** – PCI at a HN facility is preferred over fibrinolysis since this is the primary treatment for STEMI. If the facility or total transport time exceeds 120 minutes, then administer fibrinolysis (with cardiology teleconsultation) and continue coordinating transport to the HN PCI lab.
2. **UA/NSTEMI** – refractory angina, ischemic ECG changes, hemodynamic instability (with or without cardiogenic shock) or refractory arrhythmias after receiving medical therapy.

AEROMEDICAL EVACUATION

Aeromedical evacuation of all ACS patients should adhere to the following principles when possible due to the evolving nature of the disease and limited ability to fully handle the complications that come with this disease process.

1. All aeromedical evacuation of ACS patients should be evacuated by CCATT or equivalent level of care.
2. Missions should be requested as URGENT unless otherwise designated with cardiology consultation.
3. All in flight treatment should follow the recommendations put forth in the previous sections of the CPG.

IN-FLIGHT CONSIDERATIONS

1. Maintain O_2 saturations > 90%.
2. Red blood cell transfusion should be avoided unless the hemoglobin level is < 8 g/dl in patients without active ischemia.[13,36]
3. In the event of an inflight STEMI (new vs. reinfarction), then thrombolytics should be given unless a contraindication exists (see Appendix A).
4. If the patient becomes unstable in-flight, consideration of diversion to the closest location with PCI capabilities should be strongly considered. An unstable patient is one who has ongoing ischemia and the presence of either:
    a. Hypotension/shock primarily due to suspected cardiovascular causes.
    b. Recurrent ventricular arrhythmias that are unable to be controlled with ACLS medications (e.g., beta blockers, amiodarone).

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All patients presenting with a STEMI receive dual antiplatelet therapy, systemic anticoagulation and fibrinolytic therapy (unless contraindicated) within 30 minutes of arrival to a facility with these therapies available.
2. In facilities without fibrinolytics, dual antiplatelet therapy and systemic anticoagulation is administered before transfer to a higher level of care.

INTENT (EXPECTED OUTCOMES)

1. All patients with concern for STEMI or NSTEMI will have a documented consultation/teleconsultation with a cardiologist.
2. All patients diagnosed with STEMI are transferred to a PCI center.

PERFORMANCE/ADHERENCE MEASURES

1. Dual antiplatelet therapy and systemic anticoagulation are given within 30 minutes of arrival at a facility with these therapies available.
2. Fibrinolytic therapy is given within 30 minutes of confirmation of a STEMI in facilities that have these therapies, or door to PCI center within 120 minutes with facilities that can arrange for a transfer to a PCI center.
3. Consultation/teleconsultation with a cardiologist is documented for all patients with concern for STEMI or NSTEMI.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry
- Theater Medical Data Store

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting frequency will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief, Program Manager and PI Branch.

RESPONSIBILITIES

It is the Chief of Trauma or equivalent's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: FIBRINOLYTICS ABSOLUTE AND RELATIVE CONTRAINDICATIONS IN STEMI

The following table provides the absolute and relative contraindications health factors in regards to administering fibrinolytics in STEMI.

Table A-1. Absolute and Relative Contraindications

Absolute	Relative
Any prior intracranial hemorrhage	History of chronic, severe, poorly controlled hypertension
Known structural cerebral vascular lesion (e.g., arteriovenous malformation)	Significant hypertension on presentation (SBP >180 mm Hg or DBP >110 mm Hg)
Known malignant intracranial neoplasm (primary or metastatic)	History of prior ischemic stroke >3 months
Ischemic stroke within 3 months (EXCEPT acute ischemic stroke within 4.5 hours)	Dementia
Suspected aortic dissection	Known intracranial pathology not covered in absolute contraindications
Active bleeding or bleeding diathesis (excluding menses)	Traumatic or prolonged (>10 minutes) CPR
Significant closed-head or facial trauma within 3 months	Major surgery (< 3 weeks)
Intracranial or intraspinal surgery within 2 months	Recent (within 2 to 4 weeks) internal bleeding
Severe uncontrolled hypertension (unresponsive to emergency therapy)	Noncompressible vascular punctures
For streptokinase, prior treatment within the previous 6 months	Pregnancy
	Active peptic ulcer
	Oral anticoagulant therapy

Source: O'Gara PT, Kushner FG, Ascheim DD, et al. The American College of Cardiology Foundation/American Heart Association guideline for the management of ST-elevation myocardial infarction: executive summary. Circulation. 2013;127:529–555 https://www.ahajournals.org/doi/10.1161/CIR.0b013e3182742c84 Accessed May 2021.

APPENDIX B: MAJOR ADVERSE CARDIAC EVENT (MACE) HEART SCORE

This section provides the predictive HEART score for a 6-week risk of MACE.

MACEs are defined as the following:

- Acute myocardial infarction (MI)
- Percutaneous coronary intervention (PCI)
- Coronary artery bypass graft (CABG)
- Coronary angiography revealing procedurally correctable stenosis managed conservatively
- Death due to any cause

Table B-1. MACE Heart Score

History	Highly suspicious	2
	Moderately suspicious	1
	Slightly or non-suspicious	0
ECG	Significant ST-depression	2
	Nonspecific repolarization disturbance	1
	Normal	0
Age	≥ 65 years	2
	> 45 - < 65 years	1
	≤ 45 years	0
Risk Factors*	≥ 3 risk factors, *or* history of atherosclerotic disturbance	2
	1 to 2 risk factors	1
	No risk factors known	0
Troponin	≥ 3x normal limit	2
	> 1 - < 3x normal limit	1
	≤ normal limit	0

The following are MACE risk factors:

- Hypertension
- Hypercholesterolemia
- Diabetes mellitus
- Obesity (body max index > 30 kg/m2)
- Smoking (current, or smoking cessation < 1 month)

- Positive family history for coronary artery disease
- Atherosclerotic disease
- Prior MI, PCI, CABG, cerebrovascular accident/transient ischaemic attack or peripheral artery disease

The following are the score levels for MACE:

- 0 – 3: low risk; 1.7% found to have MACE
- 4 – 6: moderate risk; 16.6% found to have MACE
- 7 – 10: high risk; 50.1% found to have MACE

Sources:

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APPENDIX C: ACS ROLES

The following figures provide the ACS roles for care.

Figure C-1. ACS Role 1

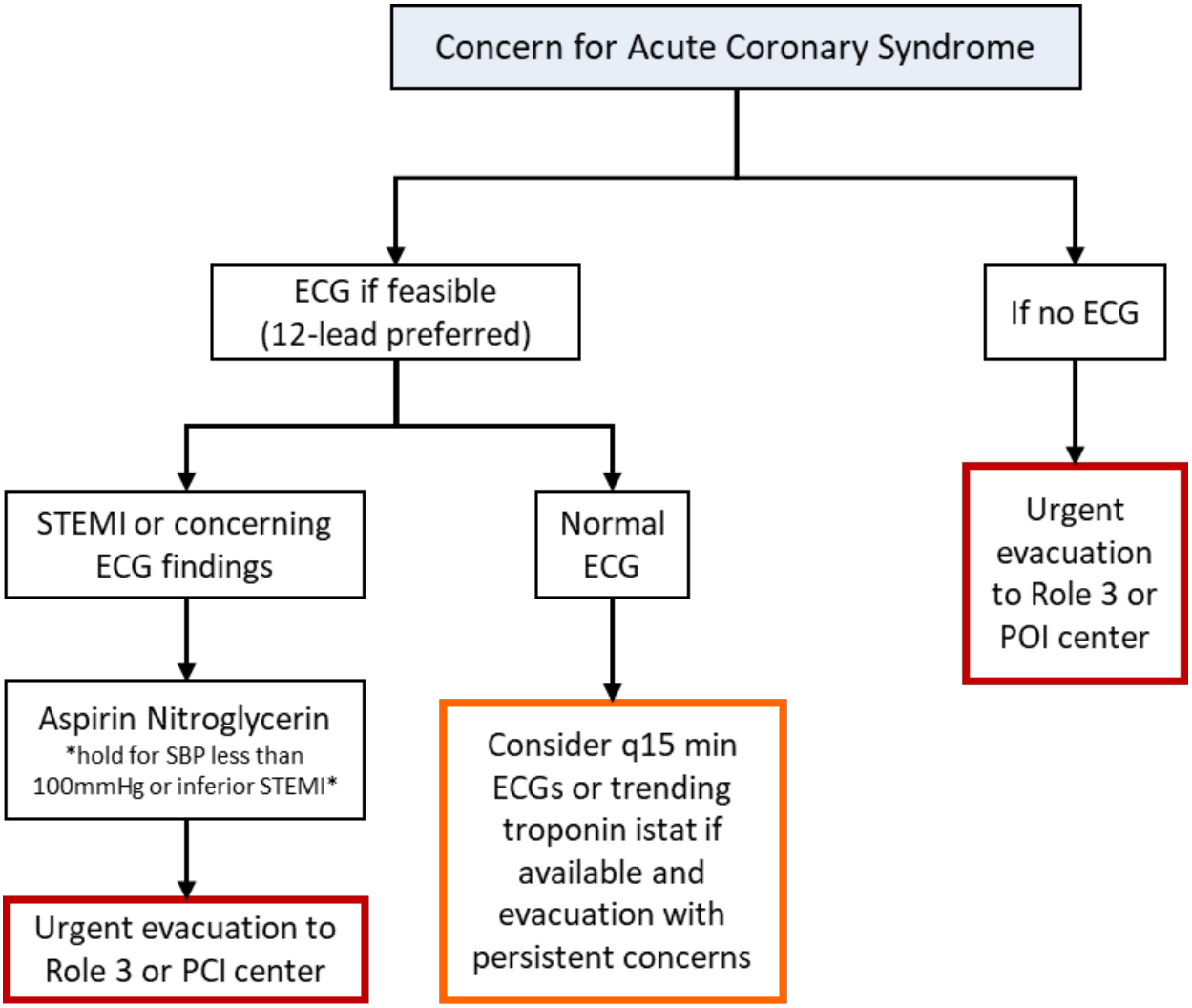

Concern for Acute Coronary Syndrome
ECG if feasible (12-lead preferred)
If no ECG
STEMI or concerning ECG findings
Normal ECG
Urgent evacuation to Role 3 or POI center
Aspirin Nitroglycerin
hold for SBP less than 100mmHg or inferior STEMI
Consider q15 min ECGs or trending troponin istat if available and evacuation with persistent concerns
Urgent evacuation to Role 3 or PCI center

Figure C-2. ACS Role 2

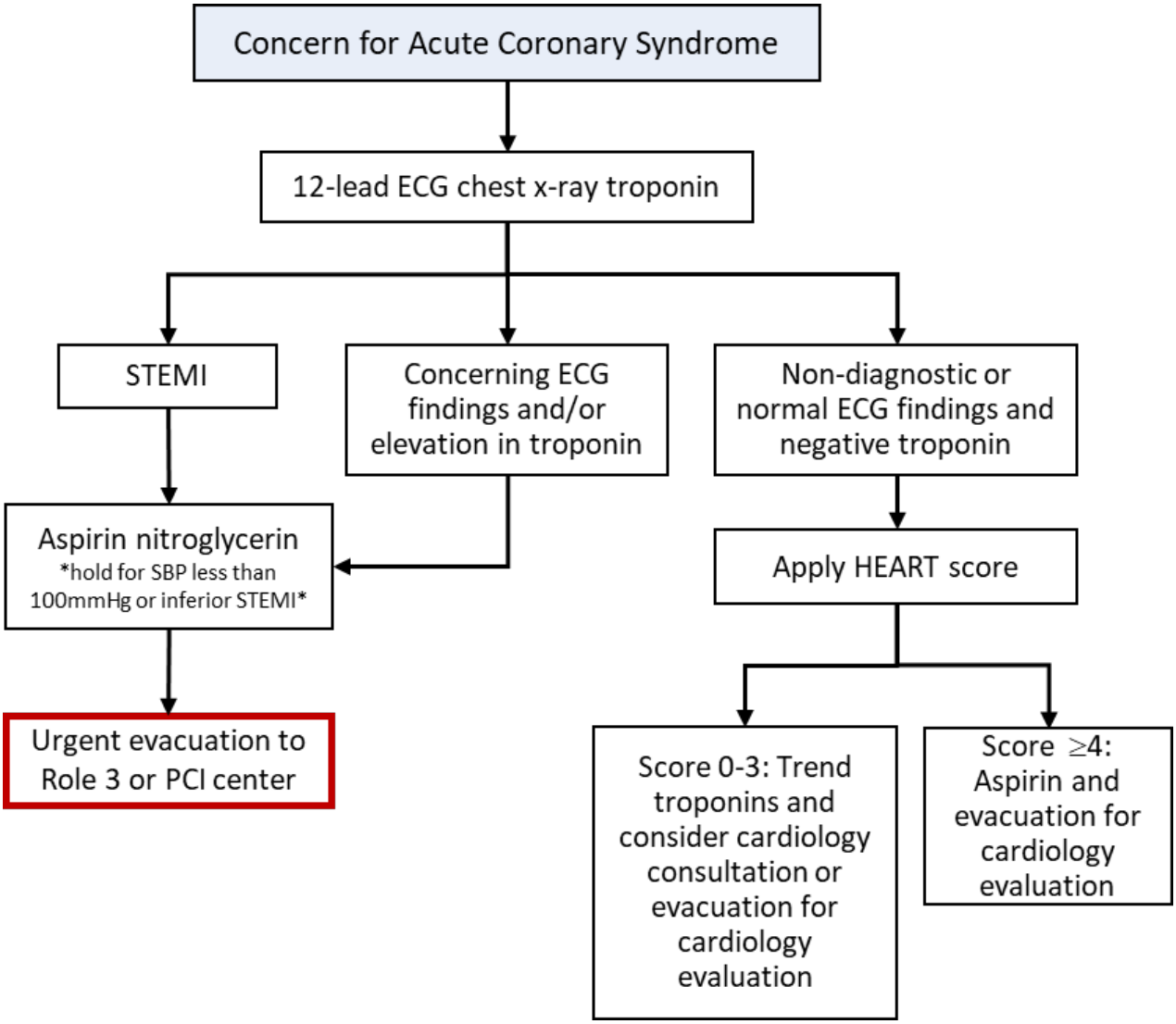
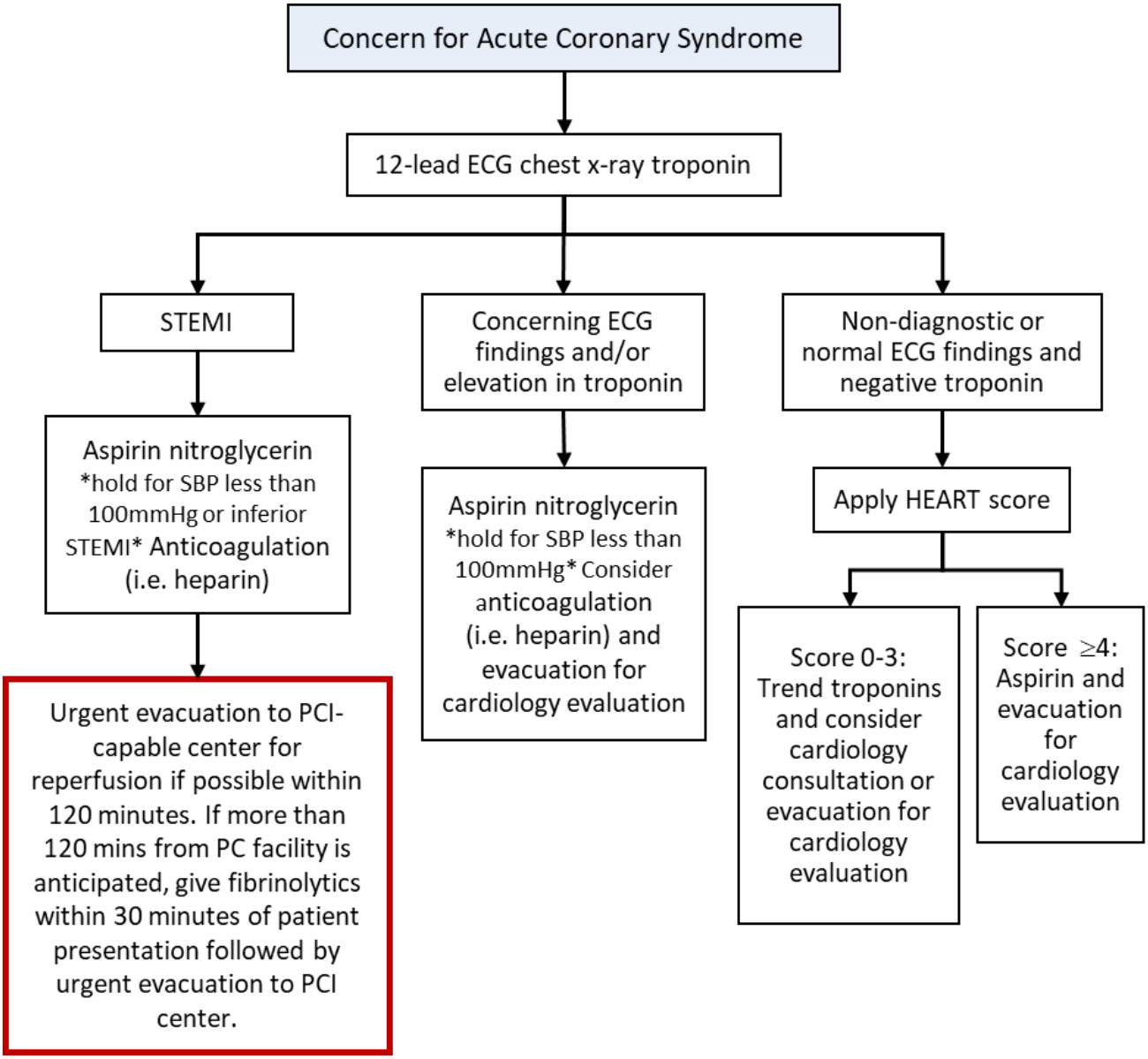

Concern for Acute Coronary Syndrome
12-lead ECG chest x-ray troponin
STEMI
Concerning ECG findings and/or elevation in troponin
Non-diagnostic or normal ECG findings and negative troponin
Aspirin nitroglycerin
hold for SBP less than 100mmHg or inferior STEMI
Apply HEART score
Urgent evacuation to Role 3 or PCI center
Score 0-3: Trend troponins and consider cardiology consultation or evacuation for cardiology evaluation
Score ≥4: Aspirin and evacuation for cardiology evaluation

Figure C-3. ACS Role 3


Concern for Acute Coronary Syndrome
12-lead ECG chest x-ray troponin
STEMI
Concerning ECG findings and/or elevation in troponin
Non-diagnostic or normal ECG findings and negative troponin
Aspirin nitroglycerin *hold for SBP less than 100mmHg or inferior STEMI* Anticoagulation (i.e. heparin)
Aspirin nitroglycerin *hold for SBP less than 100mmHg* Consider anticoagulation (i.e. heparin) and evacuation for cardiology evaluation
Apply HEART score
Urgent evacuation to PCI-capable center for reperfusion if possible within 120 minutes. If more than 120 mins from PC facility is anticipated, give fibrinolytics within 30 minutes of patient presentation followed by urgent evacuation to PCI center.
Score 0-3: Trend troponins and consider cardiology consultation or evacuation for cardiology evaluation
Score ≥4: Aspirin and evacuation for cardiology evaluation

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Acute Extremity Compartment Syndrome (CS) and the Role of Fasciotomy in Extremity War Wounds (CPG ID: 17)

Guide providers in the evaluation and treatment of patients with extremity war wounds, including the role of prophylactic and therapeutic fasciotomy.

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GOAL

This CPG provides an overview of acute extremity Compartment Syndrome (CS) and present a standardized approach to guide providers in the evaluation and treatment of patients with extremity war wounds, including the role of prophylactic and therapeutic fasciotomy.

BACKGROUND

CS is a common, controversial, and disabling problem in extremity war injuries. Seven to 11% of civilian tibia fractures result in compartment syndrome.[1-5] A similar incidence can be expected in cases of fractures from non-battle injuries in deployed areas. In contrast, combat injuries often involve a higher overall trauma burden; extreme transfusion requirements; extensive soft tissue injuries; associated arterial injuries; multi-level limb trauma; and occur in remote locations. This results in fifteen percent of all military orthopaedic trauma casualties requiring at least one prophylactic or therapeutic fasciotomy.[6]

Recent research indicates proper detection of Compartment Syndrome (CS) is lifesaving and delay in diagnosis can be lethal.[7] The operational definition of CS is a clinical syndrome wherein high pressure within a myofascial space reduces perfusion and decreases tissue viability. Therapeutic fasciotomy is indicated for established CS, and prophylactic fasciotomy is indicated when there is a substantial risk of compartment syndrome.[8-10] Fasciotomy during the lag phase between injury and syndrome onset is prophylactic. Early detection is challenging, so prophylactic fasciotomy should be routine when compartment syndrome is likely. Prophylactic fasciotomy is most commonly indicated in patients with certain “at risk” fractures and in patients with prolonged ischemia or following limb reperfusion. Injury, treatment, and casualty variables affect risk (Tables 1 and 3) and may be interrelated.[7-13] The difficulties associated with monitoring a patient’s physical exam during lengthy periods of transport must be considered in the decision to perform prophylactic fasciotomy, along with the inability to intervene surgically during Aeromedical Evacuation (AE).

The main factors are limb injury severity (particularly vessel injuries) and overall casualty injury severity (particularly shock) with a lesser factor being aggressive resuscitation (particularly >5 liters of crystalloid). Tissue edema and subsequent swelling due to injury maximizes in 1 to 2 days. Additional swelling from post-injury ischemia reperfusion (e.g., revascularization, shock, and tourniquet use) appears to delay the maximal time of limb swelling further; perhaps to 2 to 5 days post injury. High altitude (including normal AE aircraft cabin pressure), in and of itself, is not a contributor to compartment syndrome (Ritenour, et al). Compartment syndrome can lead to significant morbidity and mortality (Table 2). Surveys indicate surgeons with more training and experience, are more willing to perform fasciotomy. Once the decision is made to perform a prophylactic or therapeutic fasciotomy, a complete fasciotomy must be performed.[14] There is evidence to support complete compartment release by full-length skin and fascial incisions as being superior to limited fasciotomy. Incomplete fasciotomy, a clearly preventable problem, risks worsened patient morbidity, mortality, and functional outcome.

EVALUATION

Tissue edema due to injury peaks at 24-48 hours, but vigilance should be maintained in the first week post-trauma, especially in cases requiring sequential surgical procedures, ongoing resuscitation, or in the presence of ischemia-reperfusion. The signs and symptoms of CS are the classic “5 P’s” which include: pain; palpably tense muscle compartments; paralysis; paresthesia’s or sensory deficit; and pulselessness.[2] Pain out of proportion to the injury or with passive stretch of a muscle group is the most important clinical finding, but is often obscured in combat casualties due to altered mental status, heavy sedation, and mechanical ventilation. Palpably tense compartments are thought to be specific but not sensitive; this clinical finding is also highly subjective. Paralysis and paresthesias are less useful acutely as they can also result from direct neural trauma. Pulselessness is a late

and ominous sign in civilian CS, but occurs more commonly in combat injuries, sometimes within minutes of an arterial injury or an expanding hematoma. The most common compartment syndrome is in the anterior leg.[1-2] About 45% of all compartment syndromes are caused by tibia fracture. Open fractures, even with traumatic fasciotomy, have higher CS rates than closed fractures because they are more severe, with more swelling and more often injured arteries. The most commonly missed compartment syndromes are in the anterior and deep posterior compartments of the leg. The most commonly incompletely released compartments are also in the leg.[1]

Pressure measurement has significant limitations and is not recommended for routine use in theatre. Emerging technologies, such as ultrafiltration catheters, may eventually allow continuous pressure monitoring while providing pressure relief by suctioning interstitial fluid.[15] When monitoring patients for the development of CS, serial clinical examinations are repeated hourly when risk is high and less frequently when low. Provider experience and training improves detection. Documentation is important for later providers and performance improvement.

In one study, burns sustained in combat have been associated with an increased fasciotomy rate.[7] In the absence of crush injury, fracture, multiple trauma, over-resuscitation, electrical injury, or similar indications, prophylactic fasciotomy on burned extremities may increase morbidity and mortality and are not indicated. (For additional information on escharotomy and fasciotomy in the management of patients with extremity burns, see JTS Burn Care CPG).[16]

TREATMENT

OPERATIVE INTERVENTION

CS requires immediate operative intervention. Once intra-compartmental pressure reaches a critical threshold, only surgical treatment can interrupt the cascade of events leading to ischemia and tissue necrosis. This should be accomplished as soon as possible, as irreversible tissue necrosis occurs within a few hours. Delayed or incomplete compartment release has been associated with increased mortality and need for amputation in military casualties.[6] Therapeutic fasciotomy is performed for established compartment syndrome while prophylactic fasciotomy is performed for limbs at risk of developing CS.[8-10] The decision to proceed with prophylactic fasciotomy is based on the pattern of extremity injury, the patient's physiological profile, and operational considerations. We recommend that any limb at risk of CS in an austere location, particularly when AE is anticipated or after extremity vascular repair, should undergo prophylactic fasciotomy when they reach a fixed surgical facility. This avoids missed compartment syndrome or delayed compartment release, especially during times of high battle rhythm. The difficulties associated with monitoring a patient's physical exam during lengthy periods of transport must be considered in the decision to perform prophylactic fasciotomy, along with the inability to intervene during AE. High altitude (including normal AE aircraft cabin pressure), in and of itself, is not a contributor to compartment syndrome.[17,18]

DELAYED EVACUATION

Occasionally, casualties present with a compartment syndrome of prolonged duration (> 12 hours) due to delayed evacuation. This situation is associated with markedly increased risk of complications, including death and infection.[12] These casualties may be best treated with appropriate resuscitation, urine alkalization, mannitol use, and intensive support.[19] Such conservative care has led to better outcomes than fasciotomy in casualties with closed injuries with mechanically crushed muscle.[12] Therefore, compartment syndromes with greater than 12 hours of warm ischemia with nonviable muscle should not routinely undergo fasciotomy.[19] The role of amputation is currently unclear in this situation.

FASCIOTOMY

Once the decision is made to perform compartment release, a complete fasciotomy must be performed.[14,20] This involves releasing all compartments in the affected anatomic region over their full length. In the calf/leg, the anterior, lateral, superficial posterior and deep compartments must be released through full length incisions. Although a one-incision approach is possible in expert hands, we feel that a two incision technique should remain the standard of care in combat.[21,22] A frequent error by inexperienced surgeons is not releasing the deep posterior compartment of the calf/leg. In the forearm, the superficial and deep volar compartments must be released through an incision that extends from the lacertus fibrosus to the carpal tunnel. The dorsal compartment, when involved, is released through a separate incision. Incomplete fasciotomy can be secondary to failure to release a specific compartment or to short fascial incisions. The most commonly missed compartment syndromes are the anterior and deep posterior compartments of the calf/leg.[7] The most common incompletely released compartments are also in the calf/leg.[7] Incomplete fasciotomy is associated with worse outcomes; fortunately, improved surgical education has been shown to decrease the rate of fasciotomy requiring revision.[7,23] There is no reported experience with fasciotomy performed by non-surgeons in austere locations. We would caution that attempting this procedure outside of an operating room setting is fraught with pitfalls, including uncontrollable bleeding and iatrogenic neurovascular injury. Wound vacuum dressings or laced vessel loops are both acceptable methods of initially covering the surgical wounds.

The common reasons for incomplete calf fasciotomy are:

- Improper identification of the septum dividing the anterior and lateral compartments. This can be avoided by making an initial transverse incision in the fascia overlying the septum, then deliberately opening the anterior and lateral compartments separately, creating a so called “H” incision.
- Incomplete development of the deep posterior compartment release by not deliberately taking the soleus muscle fibers off the posterior tibia. If performed correctly, the neuro-vascular bundle should be exposed in a fully decompressed deep posterior compartment.
- Fascial incisions are too short and do not cover the entire extent of the fascial compartment, either at the knee or ankle levels.

Passive stretch pain (e.g., ankle dorsiflexion), palpation of muscles for tenseness and pulse quality combined with an index of suspicion makes up the mainstay for clinical evaluation. Pressure monitoring by manometer does not reliably diagnose CS in theater, so the diagnosis remains a clinical, not a technological diagnosis. Since there is currently no sensitive or specific technique for establishing the diagnosis of compartment syndrome, a fasciotomy should be considered in a patient with significant mechanism of injury and clinical findings suspicious for compartment syndrome.

TREATMENT OF FOOT CS

Fasciotomy for treatment of CS of the foot remains controversial. While surgical release is generally supported in the literature, the sequelae of foot fasciotomy can, in many instances, result in more severe sequelae (infection, skin grafting, difficulty with shoe wear) than result from compartment syndrome itself (claw toe deformity). The surgeon must, therefore, carefully weigh the advantages and disadvantages prior to performing foot fasciotomies.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients diagnosed with compartment syndrome
- All patients with limb AIS ≥ 3 or tourniquet time > 2 hrs

INTENT (EXPECTED OUTCOMES)

1. Compartment syndrome is diagnosed and treated prior to tissue necrosis.
2. When fasciotomy is indicated, a complete fasciotomy is performed.
3. Tourniquet times are documented.
4. The use of prophylactic fasciotomy is minimized.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients diagnosed with compartment syndrome who receive fasciotomy performed at the same role of care (or have reason for delay documented).
2. Number and percentage of patients undergoing fasciotomy who require debridement of necrotic muscle in the affected limb.
3. Number and percentage of patients with tourniquet placed who have tourniquet times (placement and removal) documented.
4. Number and percentage of patients who undergo fasciotomy who do not have a diagnosis of compartment syndrome.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DODTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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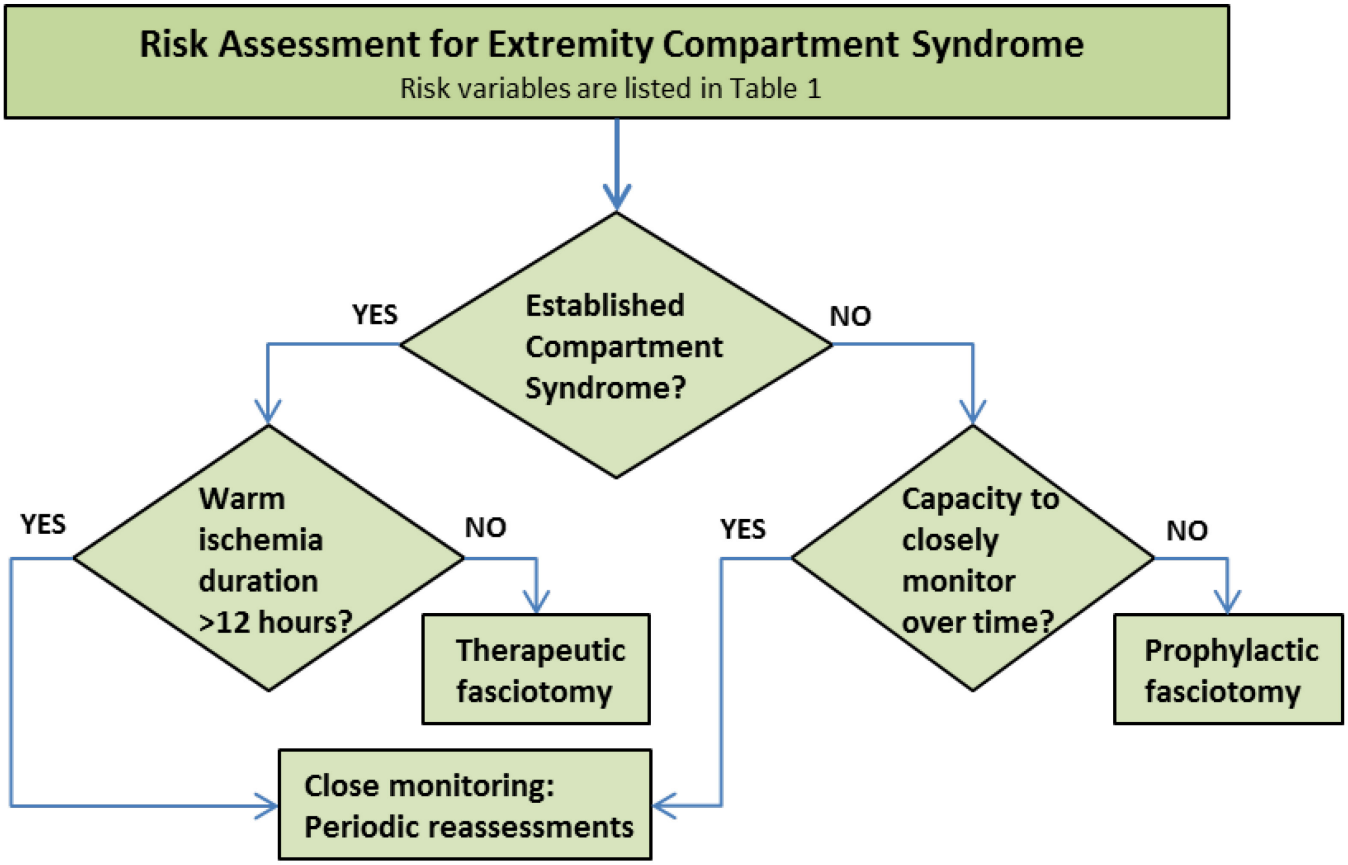
APPENDIX A: RISKS

Table 1. Risks for Acute Traumatic Compartment Syndrome	
Decreased Compartment Volume	• Tight cast or dressing, closure of prior fasciotomy, excess traction • External limb compression or crush particularly in obtunded or incapacitated casualty • Frostbite, burns or electric injury (may include escharotomy)
Increased Compartment Contents	• Edema accumulation: embolism, intravascular thrombosis, replantation, venous tourniquet, injections, extravasation, infiltration, ergotamine ingestion, ischemia-reperfusion, swelling, artery injury or spasm, revascularization procedures, prolonged arterial tourniquet use, shock hypoperfusion, angiography and catheterization, limbs positioned well above heart, mal-positioned joints (ankle dorsiflexion,) or stretched muscles • Prolonged immobilization and limb compression particularly with obtunded or drugged casualty, some surgical positioning • Hemorrhage, hemophilia, coagulopathy, anticoagulation, vessel injury • Large volume crystalloid resuscitation • Fractures particularly tibia fractures in adults, supracondylar humerus fractures in children displaced, comminuted, or open fractures increase hemorrhage, swelling, and CS risk • Popliteal cyst, long leg brace

Table 2. Morbidity Risk and Sequelae of Compartment Syndrome and Fasciotomy	
Potential Morbidity: Compartment Syndrome and Early Fasciotomy	• Skin scar, scaly skin, ulceration, tethered tendons • Postoperative arterial or graft thrombosis, thromboembolic disease • Wound infection, non-healing fasciotomy wounds • Limb swelling or chronic edema, shape change of limb, muscle hernia • Pain, paresis or paralysis, paresthesia • Coverage challenge: primary closure, delayed primary closure, skin graft, flap • Possible repair of arterial injury worsening ischemia-reperfusion injury
Potential Sequelae List: Compartment Syndrome with Late or Incomplete Fasciotomy	• Mortality, sepsis, multi-organ failure, acute kidney failure, • Myonecrosis, myoglobinemia, myoglobinuria, or rhabdomyolysis • Paresis or paralysis • Stiffness or contracture • Limb amputation, tissue loss, e.g., muscle debridement

APPENDIX B: ALGORITHM FOR CLINICAL DECISION MAKING ON COMPARTMENT SYNDROME IN A DEPLOYED SETTING



APPENDIX C: COMPARTMENT SYNDROME HEALTHCARE RECORD DATA

Table 3. Healthcare Record Data in the Setting of Compartment Syndrome During War
• Was the fasciotomy prophylactic (compartment syndrome absent) or therapeutic (compartment syndrome present)?
• When was the fasciotomy indicated and when was the injury?
• When was the procedure (to determine treatment lag)?
• Was the casualty able to be followed closely? If so, what was the clinical course? Was the casualty alert, intubated, or head injured?
• Was there a nerve injury or nerve block/regional anesthetic?
• What was the injury or risk factors (e.g., ischemia-reperfusion) that indicated the procedure?
• What are the sources of ischemia-reperfusion in the injury and care of this case?
• Associated injuries altering risk of compartment syndrome: shock, occult hypoperfusion, hypoxia, nerve dysfunction, impaired, obtunded, or uncooperative casualty, arterial injury or ischemia, fractures with soft tissue injury, over-resuscitation syndrome, coagulopathies (including hemophilia, etc.), hematoma formation, crush injury, capillary leak syndrome, and prolonged compression.
• What were the surgical findings and muscle compartment response to the procedure?
• What was the technique (dermotomy, fasciotomy, surgical approach, length of fasciotomy)?
• Was there retinaculotomy or epimysiotomy? List names of all compartments released.
• What delimited the fasciotomy extent, e.g., anterior leg fascia goes from the proximal tibial crest near Gerdy's tubercle to the anterior ankle extensor retinaculum (crural ligament)?
• List associated procedures: debridement, irrigation, fracture fixation, etc.
• Planned care: staged? Closure, repeat debridement, delayed primary, skin graft, or flap

APPENDIX D: COMPARTMENT DATA SHEET

Table 4. Data Sheet: Compartment Names, Main Muscles, and Diagnosis and Procedure Codes

Compartment	Main muscle(s)	Left or Right	Wound Notes, Compartment Syndrome (CS), Diagnoses, Indications, & Findings	Procedure(s) and Tissue Response to Procedure
			958.91: traumatic CS of upper extremity 958.92: traumatic CS of lower extremity 958.99: traumatic CS of other sites 958.90: CS, unspecified Prophylactic (CS absent) or therapeutic (CS present). Artery, vein, clot, & hematoma findings in compartment on exploration	83.12: fasciotomy of hand 83.14: fasciotomy, division of fascia 83.09: incision of fascia 86.09: escharotomy dermotomy, epimysiotomy Response: muscles bulged through fasciotomy, no bulge, pulse returned after absence
Deltoid	Deltoid			
Arm, Anterior	Biceps, Brachialis			
Arm, Posterior	Triceps			
Forearm, Volar	Flexors			
Forearm, Dorsal	Extensors			
Forearm, Mobile Wad	Brachioradialis			
Hand, Interossei	Interossei			
Hand, Central Palmar	Flexors			
Hand, Hypothenar	Digiti Minimi			
Hand, Thenar	Thumb Muscles			
Gluteus Maximus	Gluteus Maximus			
Gluteus Medius	Other Glutei			
Tensor Fascia Lata	Tensor			
Thigh, Anterior	Quadriceps			
Thigh, Posterior	Hamstrings			
Thigh, Adductor	Adductors			
Leg, Anterior	Tibialis Anterior			
Leg, Lateral	Peronei			
Leg, Deep Posterior	Tibialis Posterior			
Leg, Superficial Posterior	Gastrocnemius			
Foot, Interossei	Interossei			
Foot, Central	Flexors			
Foot, Lateral	Digiti Minimi			
Foot, Medial	Great Toe Muscles			
Iliacus	Iliacus, Psoas			

APPENDIX E: OPERATIVE NOTE TEMPLATE

Table 5. Operative Note Template for Dictation, Surgical Planning, or Data Collection

1. Patient	2. Surgeon
3. Date of Surgery	4. Anesthesia
5. EBL:	6. Tubes
7. Specimens	8. Complications
9. Implants, Devices	
10. Indication for operation: a. Established compartment syndrome (therapeutic) b. Risk of compartment syndrome developing (prophylactic)	
11. Preoperative wound appearance: a. Size (volume of damaged tissue: large surgeon hand ~500ml) b. Depth, location, contamination material or matter	
12. Preoperative imaging findings: a. Soft tissue injury seen & fracture	
13. Examination under anesthesia, fluoroscopy, and surgical exploration findings: a. Distal pulse status b. Wound size, depth, location, contamination, materials or matter; burn eschar location and depth c. Vessel status, pulse, limb perfusion, capillary refill, congestion, edema, color of skin, warmth d. Clot presence, intravascular or extra vascular site, size (volume), location e. Hematoma presence f. Compartment hardness: soft, hard i. Epimysiotomy (if done by muscle name or compartment if known) ii. Retinaculotomy (if done by name, e.g., partial proximal ankle extensor iii. Retinaculotomy extended from anterior leg compartment fasciotomy iv. Result of fasciotomy and procedure (distal perfusion and pulse; gap in fasciotomy edges on release in cm; bulging out of muscles in compartment) v. Compartments soft or hard vi. Muscle color, consistency, contractility, capacity to bleed	
14. Patient condition, status, disposition and plan.	
15. Key note for air evacuation: “Patient has been monitored for X hours after injury/surgery and has not had progression of signs or symptoms of compartment syndrome.”	

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PURPOSE

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BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

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With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Acute Respiratory Failure (CPG ID: 06)

This CPG describes the associated risk factors, diagnosis, and management of Acute Respiratory Distress Syndrome (ARDS) in combat casualties in the forward deployed environment and the resources available for safe Aeromedical transport of these patients.

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BACKGROUND

Patients with multiple injuries are known to develop lung injury[1] which can result in long-term disability or even death.[2] A recent review of combat casualty deaths following admission to a hospital demonstrated that 8% of potentially preventable deaths are from multi-organ failure which includes ARDS.[3] The purpose of this guideline is to review the diagnostic criteria for ARDS, to describe the frequency of this problem in combat casualties, and to recommend a series of management strategies to permit safe aeromedical evacuation of these patients.

Respiratory failure has been observed in combat casualties for over a century. Some degree of ARDS occurs in between 26% and 33% of combat casualties.[1,4,5] In a review of the DoD Trauma Registry (DoDTR), 152 patients with ARDS were identified over a 7 year period.[6] Independent risk factors for ARDS included female gender, shock or tachycardia on presentation, and severe injury (Military Injury Severity Score (mISS) ≥25). Patients with ARDS had a significantly increased risk of death as compared to intubated controls (12.8% vs. 5.9%, Odds Ratio 1.99, 95% confidence interval [1.12, 3.52], p=0.02). Further analysis of this population identified that increased crystalloid infusion and Fresh Frozen Plasma (FFP) transfusion independently predicted ARDS.[7]

DEFINITIONS

- ARDS develops as a result of both direct and indirect injury to the lungs. Common causes of ARDS following a direct injury include pneumonia or gastric aspiration. In combat casualties, direct insults such as pulmonary contusion, inhalation injury, and fat emboli may lead to ARDS. ARDS from indirect lung injury can occur in patients who receive multiple transfusions, who develop septic shock, or in those with severe acute pancreatitis.

- Cardiac failure or fluid overload must be ruled out when considering the diagnosis of ARDS. Several other disease processes can also mimic ARDS. Patients with these conditions will benefit from lung-protective ventilator management but may require disease-specific interventions as well. Examples include Acute Eosinophilic Pneumonia (AEP), Acute Interstitial Pneumonitis (AIP), Bronchiolitis Obliterans Organizing Pneumonia (BOOP), and Diffuse Alveolar Hemorrhage (DAH).[8]

- The definition of ARDS was updated in 2012. The new Berlin definition of ARDS reflects a range of severity from mild to moderate to severe, defines "acute onset" as within one week and specifies the need for Positive End Expiratory Pressure (PEEP) ≥5 cm H_2O.[9] The original American-European Consensus Conference (AECC) definition of ARDS which also included Acute Lung Injury (ALI)[10] is less practical; so this CPG will refer to the new Berlin definition. Timing of ARDS must occur within one week of a known clinical insult described above, or must be in the context of new or worsening respiratory symptoms. On chest imaging (CXR or CT scan), bilateral opacities must be present which are not fully explained by pulmonary edema, effusions/hemothorax, lobar collapse, or pulmonary nodules. If the above criteria are met, the degree of hypoxemia with a PEEP or Continuous Positive Airway Pressure (CPAP) of at least 5 cm H_2O determines the severity of ARDS.

    1. **Mild ARDS** = PaO_2 to FiO_2 ratio (P:F) of > 200 and ≤ 300.
    2. **Moderate ARDS** = P:F of >100 and ≤ 200.
    3. **Severe ARDS** = P:F of ≤ 100.

- The diagnosis of ARDS is typically made in patients who have respiratory failure that requires intubation and mechanical ventilation.

DIAGNOSIS

Patients suspected of having ARDS on the basis of CXR findings and ventilator settings should have their diagnosis confirmed by following the below guidance.

1. Verify that the patient is likely to have respiratory failure from either a direct or indirect pulmonary injury or the need for mechanical ventilation support.
2. Consider diagnoses which can mimic ARDS as described above.
3. Obtain a good quality anteroposterior upright CXR and look for diffuse infiltrates. Consider a chest CT if this imaging modality is available and the patient is stable for transport to CT.
4. If cardiogenic pulmonary edema and/or fluid overload cannot be fully excluded as the cause of or a contributing factor to the patient's respiratory failure, consider placing a central venous pressure catheter and obtain a trans-thoracic echocardiogram if possible.[11,12]
5. Place the patient on volume- or pressure-control ventilation.
    a. Tidal volume (V_T) approximately 6-8 mL/kg using Predicted Body Weight (PBW), see ARDSNet Card in Appendix B) targeting a plateau pressure (P_{PLAT}) ≤ 30 cm H_2O or if using a pressure control mode of ventilation, set the inspiratory pressure to 30-35 cm H_2O and then decrease it gradually to achieve a V_T of 6-8 mL/kg.
    b. Set the respiratory rate between 6 and 35 and adjust to achieve a pH≥7.3.
    c. Set PEEP (minimum 5 cm H_2O) and FiO_2 according to the ARDSNet table[23] to achieve a SpO_2 of 88-95% (PaO_2 of 55-80 mmHg). Allow the patient's gas exchange to equilibrate for 30 minutes and then draw an ABG to calculate the patient's P:F ratio.

If ARDS is confirmed, document the grade (mild, moderate, severe) in the patient's record with the diagnostic criteria used. A recent study further demonstrated that Age-Adjusted Oxygenation Index (AOI) accurately predicts prognosis in patients with ARDS.[13] Traditionally, the Oxygenation Index (OI) is calculated as where MAP is mean airway pressure. This study relied on the ARDSNet database which recorded P_{PLAT} rather than MAP; so the AOI was calculated as $(\frac{100\times P_{PLAT}}{P:F}) + Age$. These authors found that an AOI of 80-99 in the first four days of ARDS was associated with 50% mortality.

Pediatric trauma patients are also at risk for development of ARDS.[14] While there are many similarities in the pathophysiology of ARDS in adults and children, recent literature has supported a slightly different approach with the diagnostic criteria used in pediatric ARDS.[15,16] Similar to the Berlin criteria for adults, ARDS in children requires respiratory failure not explained by cardiac failure or volume overload. However, instead of utilization of a P:F ratio, recent recommendations have been made to utilize OI to grade severity of ARDS in the pediatric population. As above, OI can be calculated as $(\frac{100\times MAP}{P:F})$. Mild ARDS can be defined as an OI of 4 to <8, moderate ARDS defined as an OI of 8 to <16 and severe ARDS defined as an OI ≥16.[15,16]

MANAGEMENT

The management of patients with ARDS should safely support gas exchange without further injuring the patient's lungs.[17] In fact, using a lung-protective ventilator strategy in *all* intubated patients appears to improve clinical outcomes.[18–20] Providers must also recognize that there are also some limitations imposed by the transport ventilators and that the patient's PaO_2 will always decrease during aeromedical transport.[21,22]

In patients with ARDS, the goal is to limit barotrauma (P_{PLAT}≤30 cm H_2O or peak inspiratory pressure, PIP≤35 cm H_2O if PPLAT cannot be measured), volutrauma (V_T 6-8 mL/kg PBW) and atelectrauma (moderate to high PEEP).[17] Goals should include an SpO_2≥88-95% and a pH≥7.3 (in traumatic brain injury, this pH goal should be met with the $PaCO_2$ maintained at 35-40 mm Hg).

Early consultation with an intensivist is encouraged for all patients with moderate to severe ARDS. Military physician-to-physician consultation can be obtained by contacting Landstuhl Regional Medical Center (LRMC) at DSN 314-486-7141 or San Antonio Military Medical Center (SAMMC) at DSN 312-429-BURN (2876).

For Role 3 patient management, see Appendix A.

VENTILATOR AND GAS EXCHANGE MANAGEMENT

Lung-Protective Ventilation Settings

Once ARDS has been diagnosed, the patient should be placed on lung-protective ventilation settings according to the ARDSNet ventilator management card.[23] The patient's PBW is determined by measuring the patient's height and then using the appropriate gender-based calculation. Note there are two different PEEP tables, one with a lower PEEP and higher FiO_2 and the other with a higher PEEP and lower FiO_2. Either is acceptable, but meta-analysis suggests a trend towards improved survival using the high PEEP table in patients with moderate to severe ARDS by modern criteria.[24] In all cases, the "driving pressure" (P_{PLAT} – PEEP) should be minimized to optimize the patient's chances of survival.[25] During the initial management, a V_T of 8 mL/kg may be used, but this should be decreased to 6 mL/kg within 2-4 hours. If the P_{PLAT} remains above 30 cm H_2O, the tidal volume can be further reduced to 4 mL/kg so long as there is evidence of adequate oxygen delivery to peripheral tissues (normal lactate and base deficit).[26] Other modes of ventilation besides volume-assist-control can be used, but this should be at the discretion of an intensivist experienced in the management of ARDS.

Rescue Oxygenation Therapies

Advanced therapies for ARDS patients are limited in an austere environment. Low-level recruitment maneuvers performed by holding 40 cm H_2O pressure for 40 seconds can be performed by the patient's provider, but the team should be prepared to manage unstable hemodynamics due to decreased venous return. Other measures such as inhaled Nitric Oxide (iNO) or inhaled prostacyclin (Flolan) are not typically available in Role 3 facilities. Advanced rescue ventilator modes such as inverse ratio ventilation or Airway Pressure Release Ventilation (APRV) should be utilized under the supervision of an experienced intensivist.

Extracorporeal Life Support

Early consideration for Veno-Venous Extracorporeal Life Support (vvECLS) is vital in patients who are failing attempts at lung-protective ventilation.[27] If gas exchange and perfusion goals are not met after 12 hours of lung-protective ventilation and the patient has been paralyzed and proned, then extracorporeal support should be considered. Additionally, transport of patients who are supported with vvECLS may be safer and easier if an extracorporeal transport team is available. (See *Transport of ARDS patients* below).

Indications for initiating Extracorporeal Membrane Oxygenation (ECMO) for respiratory failure include:

1. P:F ration <100 or plateau pressures > 30cm H_2O despite optimal ventilator management.
2. Respiratory acidosis with pCO_2>70 and a pH <7.25 despite optimal ventilator management.
3. Initiation of ARDS rescue therapies (PEEP>15, prone positioning, High Frequency Oscillation (HFOC), iNO, prolonged paralysis)
4. Respiratory failure associated with significant barotrauma needed for ventilator support.

ECMO consultation is available 24 hours a day and can be coordinated through the Institute of Surgical Research (ISR) Burn Unit (210-222-BURN). Due to the dramatic sequelae of acute respiratory failure and the time required to generate a potential ECMO transport team, **early notification is paramount**. Early consultation with the ECMO team is essential, even if it is **prior to 12 hours of respiratory failure.**

NEUROMUSCULAR BLOCKADE

If a patient has severe or rapidly worsening ARDS, a short course (48 hours) of neuromuscular blockade may facilitate continued use of Lung Protective Ventilation (LPV) while eliminating such problems as ventilator dyssynchrony.[28] This strategy carries a survival benefit in patients with confirmed ARDS when used early in the course of disease (within 48 hours). Cisatricurium (Nimbex®) minimizes the risk of ICU-related neuropathy or myelopathy, as compared to other neuromuscular blockers, and does not require dose adjustment in renal or hepatic insufficiency. Thus, cisatricurium is the preferred neuromuscular blocking agent in patients with ARDS.[29, 30]

PRONE POSITIONING

If the patient's disease is primarily in the lower lobes (based on CXR or CT findings), a trial of prone positioning for 2–6 hours should be performed.[31] If the patient's gas exchange improves, continue the proning therapy. A recent study of patients with moderate to severe ARDS (P:F <150) demonstrated a mortality benefit to proning for 16 hours/day.[32] This is best done by an experienced team able to avoid tube/line dislodgment during the proning maneuver, and may not be practical in the deployed or austere setting. The EKG electrodes are placed on the patient's back and the eyes are taped shut. This approach is best implemented in the setting of a proning protocol which includes indications and contraindications, a pre-proning checklist, and a description of nursing care of the proned patient.

FLUID MANAGEMENT

Patients with ARDS in the setting of a positive fluid balance have an increased mortality.[33] Thus, early and aggressive limitation of unnecessary volume infusion is encouraged by eliminating any "maintenance IV fluid," maximally concentrating all necessary drips, and converting IV medications to enteral. If the patient's hemodynamics can tolerate diuresis, this should be pushed aggressively.[34] In the setting of hemodynamic compromise, attempts should be made to minimize volume and be judicious with any trials of diuresis. Some Role 3 facilities are equipped with Continuous Renal Replacement Therapy (CRRT) which can also be used to eliminate excess intravascular volume in the setting of poor renal function under the direction of an intensivist or nephrologist experienced in this therapy (See JTS *Hyperkalemia and Dialysis in the Deployed Setting* CPG[35]). If the patient is hypoproteinemic (i.e. total protein < 6 g/dL), albumin 25 g IV every 8 hours (100 mL 25% albumin) combined with diuresis for 3-5 days has been demonstrated to improve oxygenation and diuresis in two prospective randomized studies in patients with ARDS. The goals of therapy include a CVP < 4 mmHg with evidence of effective circulation by exam (warm, no mottling and capillary refill < 2 s) and adequate urine output (≥ 0.5 mL/kg/hr).[12]

BLOOD PRODUCT TRANSFUSIONS

Blood products carry a risk of initiating or exacerbating respiratory failure.[36-39] In a recent study of the DoDTR, moderate numbers of Red Blood Cell (RBC) transfusions (2-14) increased the risk of ARDS. Furthermore, each unit of additional plasma transfused increased the risk of ARDS in intubated combat casualties by 7%.[36] Similar findings have also been demonstrated in the civilian trauma population.[39] Thus, it is imperative to balance the benefits of Damage Control Resuscitation (DCR) against the risk of ARDS. If the patient is bleeding and needs blood volume replaced, blood products should not be withheld. Furthermore, in patients with severe ARDS refractory to maximal ventilator support, transfusion of additional RBCs may be necessary to sustain adequate oxygen delivery. On the other hand, a patient who is no longer bleeding who has asymptomatic anemia[40] or a

mildly elevated International Normalized Ratio (INR) with a normal thromboelastogram or rotational thromboelastogram likely does not need additional blood products.

CORTICOSTEROID ADMINISTRATION

Intravenous steroids have generally shown no benefit in the initial treatment of ARDS.[41] However, initiation of low to moderate-dose corticosteroids in highly-select patients can improve pulmonary mechanics and reduce ventilator and ICU days without increasing complications including infections and neuropathy/myelopathy.[42,43] This select population consists primarily of those with "late-phase" or "prolonged" ARDS, defined as duration of ≥7 days. The ARDSNet Late Steroid Rescue Study Trial demonstrated a potential benefit of steroids in the subgroup of patients with ARDS duration between 7-13 days, but potential harm of steroids when administered to patients who were at ≥14 days of duration. In patients without contraindications, the recommended regimen is methylprednisolone 2 mg/kg IV x1 followed by an infusion of 2 mg/kg/day (can be divided into every 6 hour doses) for 14 days (or for the duration of intubation, whichever is shorter). The infusion can then be tapered over 7-21 days based on clinical judgment. If steroids have not been initiated within two weeks of an ARDS diagnosis, they should be avoided due to an increased mortality with delayed therapy.[44] Of note, AEP can masquerade as ARDS and has been described in deployed military members who recently started smoking.[45] AEP is highly sensitive to steroid therapy; so it is very important to correctly diagnose AEP from the more common ARDS.

NUTRITION AND VENOUS THROMBOEMBOLISM PROPHYLAXIS

Patients with ARDS receive nutritional support (See JTS *Nutritional Support Using Enteral and Parenteral Methods* CPG).[46] Enteral feeds are preferred if the gastrointestinal system is functional. Consideration should be given to positioning a naso-jejunal feeding tube for this purpose; a naso-gastric feeding tube can also be used if a feeding tube cannot be advanced through the pylorus. Stress ulcer prophylaxis is recommended in critically ill intubated patients, and all patients with ARDS should be considered for chemical Venous Thromboembolism (VTE) prophylaxis once adequate hemostasis has been achieved.

SEDATION MANAGEMENT AND PHYSICAL THERAPY

The major long-term morbidity of ARDS is neurologic and/or musculoskeletal disability related to prolonged inactivity.[29,30] Consequently, at the earliest possible time, patients should undergo a daily awakening trial ("sedation holiday")[47] and should be started on an aggressive program of early mobilization. This consists of a staged approach even while intubated, beginning with passive range of motion (performed multiple times daily by providers, nurses, therapists, co-workers, and family) and then progressing to sitting up at the side of the bed, moving from bed to chair, and ambulating with assistance.[48, 49]

ARDS IN PEDIATRIC PATIENTS

Ventilator management of ARDS in children is similar to their adult counterparts with a goal to limit ventilator-induced lung injury. Additionally, adjunctive and rescue measures are also similar in pediatric ARDS patients.[16]

TRANSPORT OF ARDS PATIENTS

CRITICAL CARE AIR TRANSPORT TEAM (CCATT) CAPABILITIES

Intubated U.S. military patients are routinely transported out of theater by the Critical Care Air Transport Team (CCATT).[50–52] From October 2001 to May 2006, these made up 1,265 of 1,995 (63%) of all CCATT patients.[53] The decision to transport a patient with ARDS should be made jointly with the theater CCATT Director and the validating flight surgeon, the on-site CCATT physician, and the Role 3 Chief of Trauma and/or ICU Director.

Considerations should include the severity of the patient's respiratory failure, the trajectory of that respiratory failure (improving or worsening), and the experience of the team.[22]

U.S. Air Force CCATT has both the Impact 731™ (Zoll Medical Corporation., Chelmford, MA) ventilator and the LTV 1000™ (CareFusion., Yorba Linda, California) ventilator for use in transport.[54] The Impact 731 operates in volume control, pressure control, SIMV, and CPAP with and without pressure support. Up to 100% O_2 can be applied as can PEEP of up to 25 cm H_2O. Flow rates range from 0 to 100 L/min at 40 cm H_2O. Peak inspiratory pressures range from 10 to 80 cm H_2O. Inverse ratio ventilation is not possible with the Impact 731.

ADVANCED CRITICAL CARE EVACUATION TEAM (ACCET) CAPABILITIES

In 2012, SAMMC established an ECLS team and now offers long-range transport of patients with severe ARDS with or without ECLS. The team consists of a medical/pulmonary critical care physician, a surgical intensivist, an ICU nurse, and a respiratory therapist. Advanced therapies used by this team include high frequency percussive ventilator (Percussionaire VDR-4), inhaled prostacyclin (Flolan), and ECLS for the management of patients with moderate to severe ARDS who could not otherwise be safely transported.[55–58]

Indications for requesting an ACCET for transport to the U.S. include the following:

- PaO_2: FiO_2 < 100 .
- Inhalation injury.
- FiO_2 > 0.7 or pH < 7.25 on lung-protective ventilation.
- PEEP > 15 cm H_2O w/ PPLAT > 30 cm H_2O.
- Severe brain injury with $PaCO_2$ > 40 mmHg on a transport ventilator.
- Cardiogenic shock refractory to maximal medical therapy.
- Anatomic derangement (e.g., Bronchopleural fistula, pneumonectomy).
- Use of advanced ventilator modes such as APRV.
- Acute Pulmonary Embolism (PE) with cardiac arrest or with persistent hypoxemia.
- Multi-system organ failure (e.g., ARDS + Renal Failure).

ACCET team members are specifically trained in the indications for and the use of these modalities which have all been appropriately vetted through the combat casualty care and transport communities.

- High-frequency percussive ventilation can be helpful in cases of purulent pneumonia or inhalation injury by mobilizing secretions while affording safe gas exchange.[59]

- ECLS is used for adult respiratory failure with good outcomes as demonstrated in recent series using modern equipment.[60-62] Most adult ECLS is Veno-Venous which can be performed through either single site internal jugular (IJ) vein cannulation, combined IJ/femoral vein (FV) or dual-FV cannulation. Systemic heparin should be administered once surgical bleeding has been controlled. This approach has been used safely in trauma patients both in the U.S. and in Germany, including patients with Traumatic Brain Injury (TBI).[62–65]

- ACCET transports should be initiated by the local Chief of Trauma and/or ICU Director by contacting U.S. Transportation Command (TRANSCOM) through the normal intertheater evacuation procedure. This will facilitate timely activation of the appropriate team. Physician-to-physician consultation can also be obtained by contacting LRMC at DSN 314-486-7141 or SAMMC at DSN 312-429-BURN (2876). Early consultation and ECLS team activation are always encouraged.

- From Nov 2005 – Mar 2007, 524 intubated patients were transported via CCATT. Of these, five were moved by the LRMC ALRT which had been called on a total of 11 patients. Of the five ALRT patients requiring advanced support modes, four survived to hospital discharge.[66] Furthermore, of 10 U.S. combat casualties transported on either Pumpless Extracorporeal Lung Assist (PECLA) or ECLS, nine survived to hospital discharge.[55] These data underscore the importance of utilizing available resources for transporting these tenuous patients to definitive care.

OUTCOMES

In a general civilian population, the in-hospital mortality in patients with ARDS remains upwards of 40%[67] and the 5-year mortality is approximately 60%.[68] For trauma patients, ARDS increases morbidity[69] and may increase mortality as well,[70] although there is some inconsistency in the current civilian literature.[71] However, ARDS is an independent risk factor for death in combat casualties as noted above. To mitigate this risk, early LPV should be implemented along with minimizing unnecessary IV infusions, eliminating unnecessary blood product transfusions, and implementation of an aggressive physical therapy regimen if possible. Early activation of the ACCET evacuation system should also be considered.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients who receive mechanical ventilation

INTENT (EXPECTED OUTCOMES)

1. Patients with Acute Respiratory Distress Syndrome (ARDS) are treated with lung protective ventilation.
2. Advanced airway support team consultation occurs within 4 hours when criteria are met (ex. PaO2:FiO2 < 100, FiO2> 70%, PEEP > 15 cmH2O with Pplat > 30 cm H2O, severe TBI with PaCO2 > 40 mmHg, etc).

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients diagnosed with ARDS who receive initial tidal volume 6-8 mL/kg.
2. Number and percentage of patients who have advance airway support team consultation within 4 hours when criteria are met (ex. PaO2:FiO2 < 100, FiO2> 70%, PEEP > 15 cmH2O with Pplat > 30 cm H2O, severe TBI with PaCO2 > 40 mmHg, etc) and patient is eligible for evacuation (US or coalition casualties).

DATA SOURCE

- Patient Record.
- Department of Defense Trauma Registry (DoDTR).

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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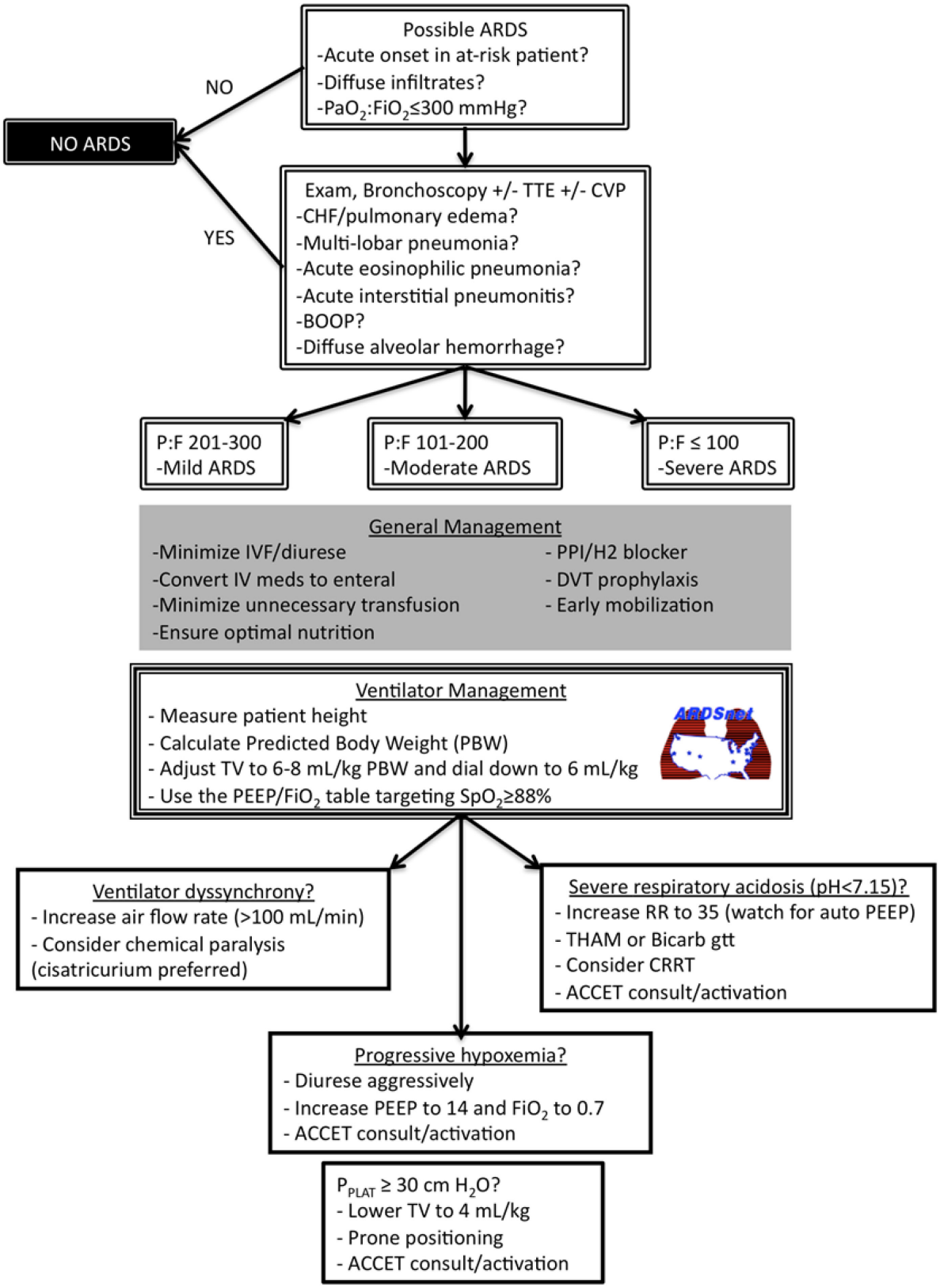
APPENDIX A: DIAGNOSIS AND MANAGEMENT OF ARDS



APPENDIX B: ARDSNET VENTILATOR MANAGEMENT FOR PATIENTS WITH ARDS[23]

NIH NHLBI ARDS Clinical Network
Mechanical Ventilation Protocol Summary

INCLUSION CRITERIA: Acute onset of

1. $PaO_2/FiO_2 \leq 300$ (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

PART I: VENTILATOR SETUP AND ADJUSTMENT

1. Calculate predicted body weight (PBW)
   Males = 50 + 2.3 [height (inches) - 60]
   Females = 45.5 + 2.3 [height (inches) -60]
2. Select any ventilator mode
3. Set ventilator settings to achieve initial V_T = 8 ml/kg PBW
4. Reduce V_T by 1 ml/kg at intervals ≤ 2 hours until V_T = 6ml/kg PBW.
5. Set initial rate to approximate baseline minute ventilation (not > 35 bpm).
6. Adjust V_T and RR to achieve pH and plateau pressure goals below.

OXYGENATION GOAL: PaO_2 55-80 mmHg or SpO_2 88-95%
Use a minimum PEEP of 5 cm H_2O. Consider use of incremental FiO_2/PEEP combinations such as shown below (not required) to achieve goal.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

PLATEAU PRESSURE GOAL: ≤ 30 cm H_2O
Check Pplat (0.5 second inspiratory pause), at least q 4h and after each change in PEEP or V_T.
If Pplat > 30 cm H_2O: decrease V_T by 1ml/kg steps (minimum = 4 ml/kg).
If Pplat < 25 cm H_2O and V_T< 6 ml/kg, increase V_T by 1 ml/kg until Pplat > 25 cm H_2O or V_T = 6 ml/kg.
If Pplat < 30 and breath stacking or dys-synchrony occurs: may increase V_T in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains ≤ 30 cm H_2O.

pH GOAL: 7.30-7.45
Acidosis Management: (pH < 7.30)
If pH 7.15-7.30: Increase RR until pH > 7.30 or $PaCO_2$ < 25 (Maximum set RR = 35).
.
If pH < 7.15: Increase RR to 35.
If pH remains < 7.15, V_T may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target of 30 may be exceeded).
May give $NaHCO_3$
Alkalosis Management: (pH > 7.45) Decrease vent rate if possible.

I: E RATIO GOAL: Recommend that duration of inspiration be ≤ duration of expiration.

PART II: WEANING

A. Conduct a SPONTANEOUS BREATHING TRIAL daily when:

1. $FiO_2 \leq 0.40$ and PEEP ≤ 8 OR $FiO_2 \leq 0.50$ and PEEP ≤ 5.
2. PEEP and FiO_2 ≤ values of previous day.
3. Patient has acceptable spontaneous breathing efforts. (May decrease vent rate by 50% for 5 minutes to detect effort.)
4. Systolic BP ≥ 90 mmHg without vasopressor support.
5. No neuromuscular blocking agents or blockade.

B. SPONTANEOUS BREATHING TRIAL (SBT):
If all above criteria are met and subject has been in the study for at least 12 hours, initiate a trial of UP TO 120 minutes of spontaneous breathing with FiO2 ≤ 0.5 and PEEP ≤ 5:

1. Place on T-piece, trach collar, or CPAP ≤ 5 cm H_2O with PS ≤ 5
2. Assess for tolerance as below for up to two hours.
   a. $SpO_2 \geq 90$: and/or $PaO_2 \geq 60$ mmHg
   b. Spontaneous $V_T \geq 4$ ml/kg PBW
   c. RR ≤ 35/min
   d. pH ≥ 7.3
   e. No respiratory distress (distress= 2 or more)
      - HR > 120% of baseline
      - Marked accessory muscle use
      - Abdominal paradox
      - Diaphoresis
      - Marked dyspnea
3. If tolerated for at least 30 minutes, consider extubation.
4. If not tolerated resume pre-weaning settings.

Definition of UNASSISTED BREATHING
(Different from the spontaneous breathing criteria as PS is not allowed)

1. Extubated with face mask, nasal prong oxygen, or room air, OR
2. T-tube breathing, OR
3. Tracheostomy mask breathing, OR
4. CPAP less than or equal to 5 cm H_20 **without pressure support or IMV assistance.**

APPENDIX C: PRONE POSITIONING IN PATIENTS WITH ARDS

PREPARATION:

1. Check for contraindications.
   - Facial or pelvic fractures
   - Anterior torso wounds or burns
   - Spinal instability
   - Increased ICP
2. Confirm ETT placement with recent CXR.
3. Ensure that ETT and all invasive lines/monitors (chest tubes, IVs, central lines) are secured.
4. Consider how patient's head, neck, shoulder girdle will be supported.
5. Stop tube feedings, evacuate stomach, cap/clamp feeding and gastric tubes.
6. Prepare airway suctioning equipment.
7. Prepare all IV tubing, catheters, etc., for prone connections.
   - Assure sufficient tubing length
   - Relocate drainage bags to opposite side of bed
   - Move chest tube drains to between legs
   - Reposition IV tubing to patient's head on opposite side of bed

TURNING

1. Place personnel on both sides and head of bed.
2. Increase FiO_2 to 1.0, and note TV, minute ventilation, peak/plateau pressures.
3. Place new draw sheet, put patient into lateral decubitus position.
4. Remove EKG leads and patches. Suction airway, oropharynx, nares as necessary.
5. Continue to proning, and reposition patient in center of bed.
6. Turn patient's face toward ventilator. Ensure airway is not kinked and has not migrated.
7. Support face/shoulders appropriately; ensure no contact of padding with eyes/orbits.
8. Position patient's arms for comfort. Avoid arm extension that might cause brachial plexopathy.
9. Auscultate chest for mainstem intubation; reassess TV and minute ventilation.
10. Reconnect and adjust all tubing, check functions.
11. Reattach ECG patches and leads to back.
12. Tilt patient in reverse Trendelenburg. Intermittent slight (200) lateral repositioning every two hours, if possible.
13. Document skin assessment on weight-bearing surfaces every shift.

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Airway Management in Prolonged Field Care

This Role 1 prolonged field care (PFC) CPG is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines, when evacuation to higher level of care is not immediately possible.

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PURPOSE

This Role 1, prolonged field care (PFC) clinical practice guideline (CPG) is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines, when evacuation to higher level of care is not immediately possible. A provider must first and foremost be an expert in TCCC, the Department of Defense standard of care for first responders. The intent of this PFC CPG is to provide evidence and experience-based solutions to those who manage airways in an austere environment. An emphasis is placed on utilizing the tools and adjuncts most familiar to a Role 1 provider. The PFC capability of airway is addressed to reflect the reality of managing an airway in a Role 1 resource-constrained environment. A separate Joint Trauma System CPG will address mechanical ventilation. This PFC CPG also introduces an acronym to assist providers and their teams in preparing for advanced procedures, to include airway management.

BACKGROUND

Airway compromise is the second leading cause of potentially survivable death on the battlefield after hemorrhage.[1] Complete airway occlusion can cause death from suffocation within minutes. Austere environments present significant challenges with airway management. Limited provider experience and skill, equipment, resources, and medications shape the best management techniques. Considerations include: limited availability of supplemental oxygen; medications for induction/rapid sequence intubation, paralysis, and post-intubation management; and limitations in available equipment. Another reality currently is limitations in sustainment training options, especially for advanced airway techniques. Due to these challenges, some common recommendations that may be considered "rescue" techniques in standard hospital airway management may be recommended earlier or in a non-standard fashion to establish and control an airway in a PFC environment. Patients who require advanced airway placement tend to undergo more interventions, be more critically injured, and ultimately have a higher proportion of deaths. The ability to rapidly and consistently manage an airway when indicated or spend time on other resuscitative needs when airway management is not indicated, may contribute to improved outcomes.[2,3]

INDICATIONS FOR AIRWAY MANAGEMENT

DISRUPTED FACE OR NECK ANATOMY

If managing an isolated injury that disrupts face or neck anatomy, healthy adults may only need a mechanical airway placed and may not require assisted ventilation if they are not heavily sedated. Examples of conditions requiring early airway management include:

- Massive facial trauma
- Burns to the face or inhalation injury with hoarseness or stridor
- Massive neck trauma
- Expanding neck mass/hematoma
- Acute pharyngeal infection (Retropharyngeal abscess, peritonsillar abscess, epiglottitis)
- Foreign body aspiration
- Anaphylaxis (airway swelling)

INSUFFICIENT OXYGENATION OR VENTILATION

These indications may be apparent on initial evaluation or may emerge during the course of patient management. If the need to establish an airway develops more gradually, additional elective airway techniques can be employed. Interventions such as prolonged manual bag or mechanical ventilation require an airway intervention to ensure best overall management. Examples include:

- Chest wall and pulmonary trauma (blunt or penetrating) such as flail segments, pulmonary contusions (from blast, blunt or crush mechanism)
- Burns with greater than 40% body surface area
- Traumatic brain injury with decreased level of consciousness (GCS ≤ 8)
- Traumatic brain injury with suspected herniation requiring hyperventilation (target $ETCO_2$ between 30 and 35)
- Procedural sedation or surgical procedure
- Respiratory failure from disease, infection, or injury:
  - Chemical or toxic inhalation injuries
  - Acute Respiratory Distress Syndrome (ARDS) from infection, massive resuscitation, drug-induced or other causes
  - Primary lung infection (pneumonia)
  - Massive pulmonary embolism
  - TRALI (transfusion related acute lung injury) or TACO (transfusion associated circulatory overload) due to massive transfusion

Table 1. TCCC Airway Management Adjuncts (Consider basic adjuncts first)

DEVICE/ TECHNIQUES	PROS	CONS	PHARM REQS TO MAINTAIN (0/+/++)	SKILL LEVEL (NM: NON-MEDIC; M: MEDIC)
Head-Tilt/ Chin-Lift	Easy	Requires hands-on continuously	0	NM
Recovery Position	Easy; tactically feasible (TCCC/MASCAL)	May limit patient assessment or ongoing management	0	NM
Sit Up/ Lean Forward	Easy and practical (position of comfort)	May indicate impending airway loss	0	NM
Nasopharyngeal Airway (NPA)	Easy	Risk of nose bleeds with placement	0	NM
Oropharyngeal Airway (OPA)	Easy	Not tolerated in conscious patient	+	NM
Supraglottic Airway (SGA)	Easy	Not tolerated in conscious patient	++	M

DEVICE/ TECHNIQUES	PROS	CONS	PHARM REQS TO MAINTAIN (0/+/++)	SKILL LEVEL (NM: NON-MEDIC; M: MEDIC)
Oral Endotracheal Tube (ETT) Airway	Familiar to trained providers; Definitive; No surgical incision needed	Skill sustainment challenging, requires neuromuscular blockade (rapid-sequence intubation) for best success, may require suction to visualize vocal cords, requires sedation (potential limitation in PFC)	++	M+
Cricothyrotomy (Cric)	Definitive; Better tolerated than Oropharyngeal (OP), SGA or ETT. May require less sedation to sustain once in place	Invasive procedure, high failure rate in some studies.[4,5]	+	M

For Pharm Reqs: Maintain: 0 = no additional medications; + = some or intermittent dosing medications required; ++ = continuous or multiple medications required

MACHINE, SUCTION, MONITOR, AIRWAY, INTRAVENOUS ACCESS, DRUGS

Checklists are commonly used in medical practice. In preparation for an advanced procedure (including securing an airway) using an acronym or other checklist approach will prove invaluable. One such acronym, originally developed as a simple pre-operative anesthesia checklist, is presented.
The MSMAID acronym (Machine, Suction, Monitor, Airway, Intravenous access, Drugs) organizes an approach to preparation for airway management and may also prove useful in preparation for other procedures.

The patient's condition dictates the available time for a provider to consider all items on this checklist. A rapidly deteriorating patient with airway disruption or compromise will need the airway procedure first and follow-on considerations later. If a patient can be more appropriately classified as semi-urgent (e.g., worsening respiratory status due to an underlying pulmonary cause) the provider will have more time to consider the algorithm and prepare. Logistic considerations, and sometimes considerable time constraints, will affect preparation for advanced procedures. Recommendations follow the "minimum, better, best" format.

MACHINE

(Equipment required post-intubation)

- **Minimum**: Bag-Valve-Mask (BVM) with positive end-expiratory pressure (PEEP) valve
- **Better**: Automated portable ventilator (preferably with PEEP); oxygen concentrator
- **Best**: Full-feature portable ventilator (e.g. several ventilatory modes, PEEP); supplemental oxygen if available

Managing ventilators or advanced equipment unfamiliar to a provider presents challenges. Initiate telemedicine consultation for best guidance.

PEEP is important for prolonged ventilation. PEEP is the pressure in the airway at the end of the expiratory phase which prevents the alveoli of the lung from completely collapsing. In a spontaneously breathing person, this pressure is maintained by closing the glottis, clearing the throat, coughing, sighing, etc. With an invasive airway, the glottis is bypassed with the tube and "natural" PEEP is lost. PEEP should therefore be introduced into the ventilated patient using a PEEP valve on the BVM or using the PEEP setting on a ventilator. When using BVM or ventilator, provide PEEP (recommended initial setting is 5cm H2O).[6]

SUCTION

- **Minimum**: Improvised suction (i.e. syringe + nasopharyngeal airway [NPA]) and patient positioning if not contraindicated
- **Better**: Manual suction bulb with adapter
- **Best**: Powered commercial suction with oral tip and in-line endotracheal tube suction adapter

Suction should be available when establishing and maintaining an airway to remove excessive secretions or blood. It is particularly important to utilize suction to facilitate view of the vocal cords during endotracheal intubation. In addition, suction should be available for routine patient care and maintenance requirement for any intubated patients. Suction should be utilized as needed to remove secretions, mucous or blood from the airway device or oropharynx. In the event of high airway pressures, suction may be used to remove mucus/mucus plugs or to clear obstructions. In the case of thick secretions, a saline flush of 1-2 mL followed by in-line suctioning of the endotracheal tube may be useful.
Note: *During in-line suctioning of tubes, the suction should only be applied when withdrawing the catheter and not upon initial insertion.*

MONITOR

(Monitoring and telemedicine support)

- **Minimum**: Pulse oximeter (SpO2), assistant to monitor respirations and record manual vital signs. Trending vital signs documentation. PFC flow sheet is recommended. Refer to *PFC Documentation CPG*.[7] Voice or data connections to perform telemedicine communication
- **Better**: Portable Capnometry ($ETCO_2$)/capnography in addition to SpO2. Transmit photographs from smartphones or personal devices to augment telemedicine communications.
- **Best**: Automatic vital signs monitor with SpO2, $ETCO_2$/waveform capnography, +/- electrocardiogram (EKG); Synchronous (real-time continuous) telemedicine using video or remote patient monitoring systems

Monitoring is the active process of assessing the patient throughout a procedure. It involves the gathering, documenting and interpretation of vital signs and other data, and the continuous assessment of their clinical status. Telemedicine can be an important adjunct and critical capability to employ when monitoring a patient undergoing complex procedures.

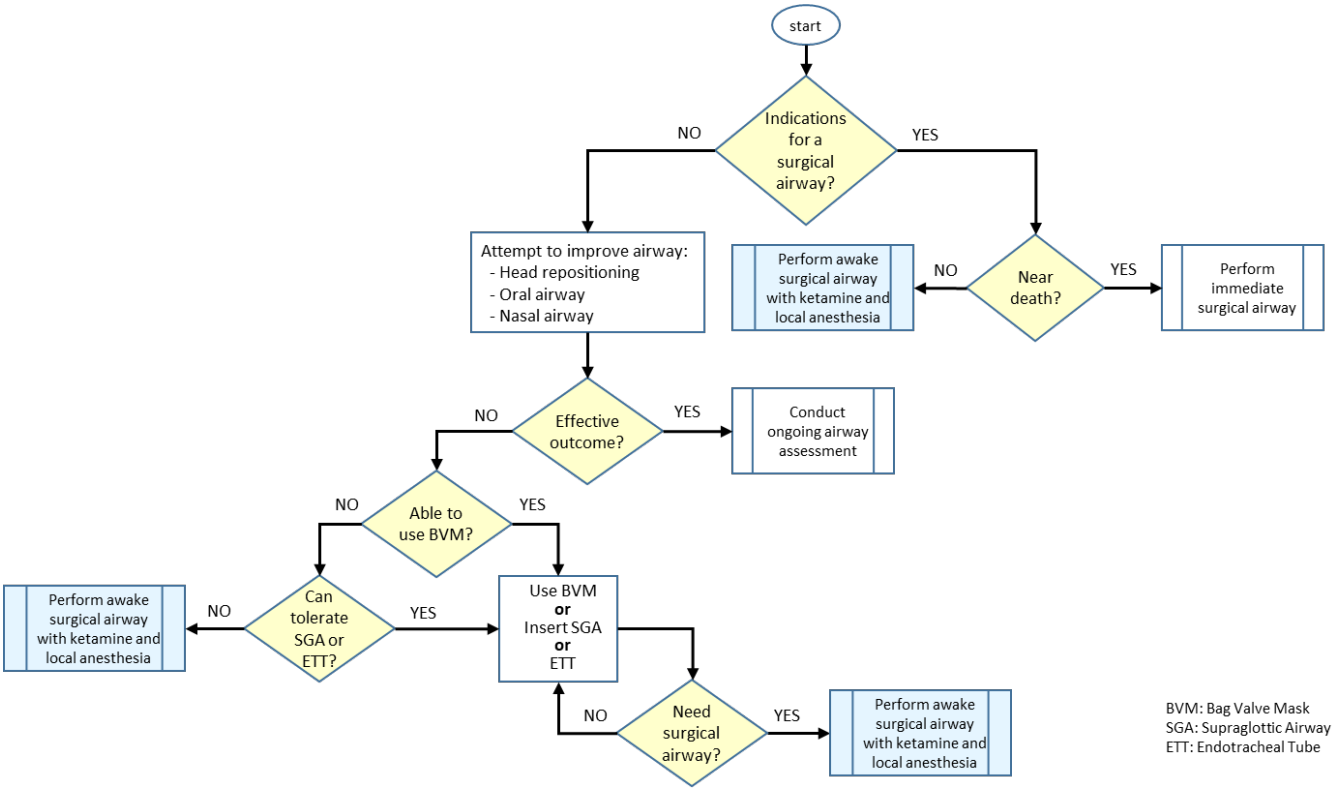
AIRWAY

- **Minimum**: Medic is prepared for a ketamine cricothyroidotomy.
- **Better**: Add ability to provide continuous sedation.
- **Best**: Add a responsible rapid-sequence intubation capability (to include chemical paralysis) with airway maintenance (to include suction) and continuous sedation.

Per the PFC Capabilities Position Paper, a definitive airway requires control of the patient's airway with an inflated cuff in the trachea. In addition, sedation is needed to keep the patient comfortable and sustain the airway.[8]

A proposed algorithm was developed by Mabry RL et al for an awake surgical airway (Figure 1).[9] This algorithm incorporates the skills recommended for Tactical Combat Casualty Care and presents the decision process deemed adequate (minimum standard) for definitive airway control in PFC. The airway algorithm is presented in its published form and surgical airway is synonymous with cricothyrotomy. As noted above, the indications for surgical airway include disrupted face or neck anatomy, as well as a need for prolonged positive pressure ventilation in a resource constrained PFC environment. Consider temporizing, if possible, with basic airway maneuvers or other airway adjuncts (e.g.; NPA, SGA). Please see Table 1.

Figure 1. An Awake Patient Surgical Airway Algorithm



Source: Mabry RL, Kharod CU, Bennett BL. Awake cricothyrotomy: a novel approach to the surgical airway in the tactical setting. Wilderness Environ Med. 2017;28(2S):S61-8. Adapted with permission from the Wilderness Medical Society. ©2017 Wilderness Medical Society.

Positioning of the patient to help clear airway obstruction should be considered first, when possible. The simple option of placing the patient in a sitting position, placing the patient in the lateral "recovery" position, or head tilt-chin lift/jaw thrust maneuver may be enough to ensure adequate respirations. Simple adjuncts such as a nasal or oropharyngeal airway (in an unconscious patient) may be utilized in addition to proper positioning to help ensure a clear airway.

For those patients requiring active airway assistance, the first step should be inserting an NPA to open the airway. BVM ventilation is the next step in the algorithm and though it appears to be relatively simple, the procedure requires preparation, training and skill to perform correctly. A spontaneously breathing patient may prove challenging, but properly delivered, synchronous breaths may be the only requirement to assist a patient's respirations. Care should be taken to ensure proper volume and rate of bag-delivered breath. One hand should provide moderate pressure to the bag for no more than 50% of the volume of an adult bag or just enough to see the chest begin to rise at a rate of 12-16 breaths per minute (one breath every 4-5 seconds) initially. It is important to avoid hyperventilation through large or rapid breaths, particularly with traumatic brain injury (TBI) casualties, therefore $ETCO_2$ monitoring is indicated for all patients requiring assisted ventilation and all patients with altered mental status (including both TBI casualties and sedated patients). BVM is an important airway management skill (see Appendix C: Bag-Valve-Mask Technique for a detailed description). It is highly recommended that all PFC training on airway skills cover BVM skills and techniques.

OP and SGA insertion can present a considerable noxious stimulus and may not be tolerated by conscious or even some semiconscious patients. Additionally, the dyssynchronous use of BVM ventilation may lead to poor patient cooperation, abnormal tidal volumes, gastric insufflation (and resultant regurgitation/aspiration), or other complications.

The decision to perform a cricothyroidotomy is one that is sometimes difficult. When possible, in urgent but not emergency situations, a telemedicine call should be considered to help with medical decision making.

An important adjunct to passing an endotracheal tube, either via the cricothyroid membrane or the oropharynx, is the use of a gum elastic bougie (sometimes also referred to as an Eschmann Stylet or, simply bougie). This device is simple, rugged and should be used to guide tube placement. The bougie is placed in the trachea before the endotracheal tube and may be used first to confirm proper positioning by either tactile discrimination (feeling the tube bump against the tracheal rings on introduction), or by encountering a hard stop when abutted against the carina. An endotracheal tube is then introduced over the bougie into the trachea. Lastly, the bougie is removed. A bougie may also be used to change tubes in the case of a tube malfunction. This may be accomplished by placing a bougie in a tube that is currently positioned, remove the tube over the bougie (ensuring the bougie remains in the proper position within the airway lumen), and replacing a new tube over that bougie. Remove the bougie, leaving the new tube in place. Confirmation procedures discussed below must be repeated once the new tube is in place.

Consistent with TCCC guidelines, the routine use of orotracheal intubation is not recommended as the minimum standard in PFC. This procedure requires considerable skill and sustainment;[10] and requires appropriate sedation for both rapid sequence intubation and post-intubation management. If a provider is appropriately trained, current and practiced in the procedure, and has the required support equipment and medications, then orotracheal intubation may be considered. Although preferred when

possible, training in orotracheal intubation is not required to obtain a definitive airway in the PFC operational setting. Consider basic measures first before proceeding to either type of invasive airway. Additional details on orotracheal intubation are included in the *JTS Airway CPG*.

Airway management in the tactical setting requires a different conceptual approach than airway management in the hospital, or even the civilian prehospital environment. Differences in epidemiology, injury patterns, equipment and environment must be considered if airway management is to be optimized. First, most military casualties requiring a prehospital airway have trauma to the head, face or neck. Surgical airway is often the final common pathway due to bleeding or distorted anatomy. In comparison, most airways in the civilian prehospital environment are placed in elderly people for cardiac arrest. When reliable suction and oxygen delivery are not available, or personnel are not experienced in rapid sequence intubation using neuromuscular blockade, a definitive airway will often mean a surgical airway.

Proper Tube Placement

- **Minimum**: Visualization of the tube passing through the vocal cords (in the case of endotracheal intubation); auscultation of epigastric region (should be silent) and bilateral lung sounds (should be present). Colorimetric capnography + endotracheal detection device (EDD). Easy bilateral rise and fall of the chest + misting of the tube + no signs of gastric insufflation. (Reassess frequently and have another medic double check if unsure.)
- **Better**: Minimum plus portable capnometer. Ultrasound if trained/available to guide and/or verify placement
- **Best**: Continuous $ETCO_2$/waveform capnography

Verification of correct tube placement must be performed every time as incorrect tube placement may be fatal. The REACH study[5] showed that right mainstem and hypopharynx placement are the most common locations of incorrect placement of ETT. Esophageal intubation is also common. Subcutaneous placement of cricothyroidotomy tube may occur. Use capnography to verify correct tube placement as tube misplacement can be fatal. Auscultate, if possible, to verify bilateral breath sounds. If ultrasound is available, this can be used to further verify placement in the correct position.[11]

IV/IO ACCESS

- **Minimum**: If (IV) / intraosseous (IO) attempts fail or when unavailable: medication may be given intramuscularly or intranasally for immediate sedation to facilitate surgical cricothyroidotomy. Continue attempts at IV/IO access after airway has been controlled
- **Better**: 1-2 patent IV/IO
- **Best**: 2-3x patent intravenous IV/IO with additional IO device on standby

Though an important consideration to administer medications and fluids, do not delay an emergent airway to obtain IV/IO access in the instance you are the sole provider.

Ultrasound may be used to help identify small or deep veins. Ultrasound guided IV access may be attempted if trained. Other sites to consider for superficial IV attempts include the external jugular and saphenous veins. If appropriately trained, consider central venous access or venous cutdown.

DRUGS

Airway Placement

- **Minimum**: Local anesthetic for cricothyroidotomy (superficial skin anesthesia plus 1-2 mL injected through the cricothyroid membrane); or placement without medications in unconscious patient. **Note: most sedating agents can be given IM if IV/IO has not been established
- **Better**: Any IV/ IO sedating agent (opioid, benzodiazepine: reference the *Analgesia and Sedation Management for PFC CPG* for procedural doses of such agents).[12]
- **Best**: Procedural dose ketamine (1-2 mg/kg IV push) for ETT or cricothyroidotomy placement + local anesthetic (lidocaine) for cricothyroidotomy placement

Prolonged Sedation

(post-airway placement)

- **Minimum** (without IV access): Ketamine (sedation dose), 3-4mg/kg IM
- **Better**: IV/IO pushes of ketamine, opioid, and/or midazolam (alone or in combination as per the individual's scope of practice, experience and availability of medications)
- **Best**: Ketamine IV/IO Drip. Hydromorphone or alternate opioid IV/IO push for breakthrough pain and midazolam IV/IO push as needed for sedation

(Reference Analgesia and Sedation Management in PFC CPG for details and drug doses).[12]

Be cautious with sedation, advanced airway placement and positive pressure ventilation in patients who are hypotensive or under-resuscitated. Blood pressure can fall rapidly during airway management due to a variety of mechanisms.

In all cases, monitor BP closely (every 1-2 minutes during the procedure, every 3-5 minutes for 15 minutes post-procedure). A BP drop may be brief (if due to vagal effects of epiglottis stimulation during ETT placement) or sustained (due to positive pressure ventilation, increased intrathoracic pressure and decreased venous return to the heart). Loss of sympathetic drive secondary to pain and sedation medications, and/or continued hypovolemia can also result in hypotension. Continue resuscitation with blood products (trauma patients) or crystalloid (non-trauma patients) if a hypotensive patient requires immediate airway interventions. Be prepared to support blood pressure with vasopressors (e.g. epinephrine bolus or drip) if trained or under direct telemedicine guidance.

Neuromuscular blockade (succinylcholine, rocuronium, vecuronium, etc.) is NOT recommended for use by the average practitioner of PFC. Though these are standard medications to use in rapid sequence intubation and ventilator management, their potential lethality in inexperienced hands does not justify routine recommended use. If trained and/or under direct supervision of telemedicine support, the use of neuromuscular blockade may be considered, subject to local medical direction and protocols.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All patients who received ETT/cricothyroidotomy/supraglottic airway/NPA
2. All patients with compromised airway (initial GCS < 8 or abbreviated injury scale (AIS) head and neck ≥ 3, or AIS face ≥ 3).

INTENT (EXPECTED OUTCOMES)

1. All injured patients who present with obtundation (GCS<8), apnea, respiratory distress or insufficiency, airway obstruction, or impending airway loss will have a secure and definitive airway established expeditiously upon arrival to a Role 2 or Role 3 if not done prehospital.
2. SpO2 is maintained between≥ 90% and 96%. SpO2 >96% is not necessary.[13]
3. Patients with a definitive airway (endotracheal tube, cricothyroidotomy, tracheostomy) have $ETCO_2$ monitoring to confirm airway placement.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who had a secure and definitive airway (endotracheal tube, cricothyroidotomy, tracheostomy) established or verified, or documentation of appropriate intervention.
2. Number and percentage of patients in the population of interest with SpO2 < 90%<80%, <70%, <60%.
3. Number and percentage of patients who had definitive airway (endotracheal tube, cricothyroidotomy, tracheostomy) with $ETCO_2$ documented at the same role of care where the procedure is done.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: AIRWAY EQUIPMENT

AIRWAY EQUIPMENT

- **Minimum** (Ruck/Aid Bag): Nasopharyngeal airway, Cricothyrotomy kit; BVM with PEEP valve
- **Better**: Minimum PLUS supraglottic airway, gum elastic bougie to facilitate intubation, nasogastric/orogastric tube
- **Best**: Better PLUS endotracheal tubes or video laryngoscopy equipment is preferred (direct laryngoscope only if video equipment not available).[1]

WAVEFORM CAPNOGRAPHY

- **Minimum**: Colorimetric $ETCO_2$ detector
- **Better**: Portable capnometer
- **Best**: Waveform capnography on patient monitor

See Appendix G for Capnography Interpretation

HEAT-MOISTURE EXCHANGER

Heat-Moisture Exchangers (HME) are small, relatively inexpensive, in-line ETT adjuncts that contain hygroscopic salts that utilize differences in vapor pressure, expired moisture content, and the patient's temperature to increase the humidity of inspired air. Increased moisture on inspiration helps maintain alveolar moisture. Capnography should not be positioned in-line following HME as these moisture devices can increase breathing resistance and work of respiration, as well as increase breathing apparatus dead space (especially in pediatric patients). This may lead to potential worsening hypercapnia and respiratory acidosis. Recommended order: endotracheal tube-capnograph-HME device (proximal to distal).

NASOGASTRIC/OROGASTRIC TUBE:

Placement of a nasogastric (NG) or orogastric (OG) tube should be considered following intubation of a patient in order to decompress gastric contents, prevent aspiration and gastric distention.

- If only supraglottic airway access is available, consider using a supraglottic device that incorporates an orogastric tube port.
- Always measure the distance from nose to stomach and note the distance prior to insertion, then verify epigastric sounds. Verify placement with second practitioner if sounds are questionable or difficult to auscultate.
- Do not feed, aggressively hydrate or give oral medications through an OGT or NGT without telemedicine guidance. Always reassess tube position prior to putting anything into stomach to ensure proper gastric placement. Feeding should not be considered until 72 hours after injury in the PFC environment. If volume instilled is too large or rate is too fast, there is increased risk for vomiting. If feeding or hydration is begun through an OGT or NGT, they must be accurate, measured, and monitored. Safe airway management takes precedence over nutrition.

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SUGGESTED PACKING LIST

	EQUIPMENT	NOTES
Minimum	Nasopharyngeal airway (NPA)	
	Oropharyngeal airway (OPA)	
	Cricothyroidotomy kit: a standardized kit should include at a minimum a #10 scalpel, a tracheal hook (or small, curved hemostat), an airway tube, a 10mL syringe, and a securing strap. The airway tube may be a prefabricated cricothyroidotomy tube such as that included in the Cric-Key (Control Cric), a Shiley tracheostomy tube, or a 6.0-sized endotracheal tube.	
	Bag valve mask (BVM)	
	PEEP valve: either separate device, or affixed to the BVM device	
	Capnography/capnometry device	
	Bougie	
Better	Additional endotracheal tubes	
	Portable suction device	
Best	Supraglottic airway: options include LMA (Size 4 if only one; size 5 for >90kg patient) or King-LT.	
	Waveform capnography	
	Commercial power suction device	
	Automatic (electronic) patient monitor	
	Direct laryngoscope: Macintosh blade size 3 or 4 for adults; Miller 1 or 2 for infants and small children as needed. Video laryngoscope preferred (direct laryngoscope only if video not available). [1]	For those trained in endotracheal tube placement and opt to include equipment in their aid bag
	Endotracheal tubes: for cricothyroidotomies (6.0 mm tubes). Personnel trained in endotracheal intubation should also carry a 7.5 or 8.0mm tube for primary intubation. A 7.0 mm tube should be carried as a secondary ET tube in case of difficult intubation. (If pediatric trauma is common, consider adding smaller sizes, but these should be limited to the most common ages expected to encounter, and calculated on the classic rule of tube size = 4 + (age/4). Examples of what to carry include 4.0 mm uncuffed for infants, and 6.0 cuffed for older children).	For those trained in endotracheal tube placement and opt to include equipment in their aid bag
	Video laryngoscope: hand-held devices should utilize a blade with an angle that allows for direct laryngoscopy function should the video screen/battery fail during intubation.	For those trained in endotracheal tube placement and opt to include equipment in their aid bag
	Mechanical ventilator	
	Pediatric-sized equipment	
	Other equipment listed above but not carried due to cube/weight restrictions	

APPENDIX B: AIRWAY MANAGEMENT NURSING/CONTINUED CARE

Long-Term Airway Management, Nursing and Prolonged Field Care

Below is the recommended Prolonged Field Care Nursing Flowsheet to use as a guide.*

Patient ID:			Time	1hr	2hr	3hr	4hr	5hr	6hr	7hr	8hr	9hr	10hr	11hr	12hr	13hr	14hr	15hr	16hr	17hr	18hr	19hr	20hr	21hr	22hr	23hr	24hr
	Action (suggested interval)	Interval																									
Vitals	Check BP/HR/RR/T/SPO2/$ETCO_2$ (Q1H)																										
	Check Peripheral Pulses (Q1H)																										
	Check Skin Temp and Color (Q1H)																										
	Check Lactate (Q4H)																										
	Check Blood Glucose (Q8H)																										
Ins/Outs	Check Drip Rates/Fluids In (Q1H)																										
	Check Urine Output (Q1H)																										
	Check Urine Dipstick (Q1H)																										
	Perform NG/OG Tube Care (Q2H)																										
	Perform Foley Care (Q24H)																										
	Flush PRN Locks (Q8H)																										
Pain/Sedation	Check GCS/RASS/PAIN (Q1H)																										
	Give Pain Rx (per Rx)																										
	Give Sedation Rx (per Rx)																										

Patient ID:			Time	1hr	2hr	3hr	4hr	5hr	6hr	7hr	8hr	9hr	10hr	11hr	12hr	13hr	14hr	15hr	16hr	17hr	18hr	19hr	20hr	21hr	22hr	23hr	24hr
HEENT	Perform Tube Suctioning (PRN)																										
	Perform Oral Suctioning (PRN)																										
	Perform Nasal Care/Moisten (Q4H)																										
	Perform Oral Care/Moisten (Q4H)																										
	Apply Lip Balm (Q1H)																										
	Apply Eye Ointment/Drops (per Rx)																										
	Brush Teeth (Q12H)																										
	Change All Tape (Q24H)																										
Respiratory	Check Ventilator Settings (Q1H)																										
	Auscultate Lungs (Q1H)																										
	Turn, Cough, Deep Breathe (Q1H)																										
	Check Chest Drainage (Q1H)																										
Integumentary	Check S/S Compartment Syndrome (Q2H)																										
	Reposition (Q2H)																										
	Check Padding (Q2H)																										
	Perform LE Massage (Q2H)																										
	Check Dressings (Q4H)																										

Patient ID:			Time	1hr	2hr	3hr	4hr	5hr	6hr	7hr	8hr	9hr	10hr	11hr	12hr	13hr	14hr	15hr	16hr	17hr	18hr	19hr	20hr	21hr	22hr	23hr	24hr
	Do A/P Limb ROM (Q8H)																										
	Wash and Dry Skin (Q24H)																										
	Perform Burn Skin Care (Q24H)																										
	Irrigate Wounds (Q24H)																										
	Debride Wounds (Q24H)																										
	Change Dressings (Q24H)																										
	Give Antibiotics Rx (Q24H)																										
Gastrointestinal	Give PPI Rx if Indicated (per Rx)																										
	Give Antiemetic Rx (per Rx)																										
	Auscultate Abdomen (Q2H)																										
	Palpate Abdomen (Q2H)																										
	Give Food/Nutrition (Q8H)																										
Extra Stuff	Check O2 Supply																										
	Check/change batteries																										
	Compression Socks/Stockings																										

AIRWAY-SPECIFIC PFC NURSING GUIDELINES/ASSESSMENT/TASKS

- Oral Suction (or in-line/tube suctioning, if placed) as indicated during routine patient assessments
- Nose and mouth moistened Q4H
- Lip Balm applied Q1H
- Teeth brushed Q12H - Prevents pneumonia and other infections.
- Auscultate lungs Q1H. If available, get a second medic to double check and verify if sounds are questionable or cannot otherwise auscultate. Extra diligence should be given to check for diminished breath sounds for suspected pneumothorax, as well as for pulmonary edema, especially if giving aggressive fluids in the case of a massive resuscitation, or replacement fluids. Consider ultrasound evaluation if available.

Naso/Orogastric Tube (NGT/OGT) and Abdominal Care

(as applicable)

- Consider placing an NG/OG tube for prolonged care of intubated/cricothyrotomy patient or those with an SGA in place (if a compatible port is available on the SGA).
- Abdominal palpation AND auscultation Q2H.
- Nutrition ONLY under telemedicine guidance (optional and not indicated in first 72 hours).

**Loos PE, Glassman E, Doerr D, et al. Documentation in prolonged field care. J Spec Oper Med. 2018; 18(1): 126-32.*

APPENDIX C: BAG-VALVE-MASK TECHNIQUE

Proper technique is essential to perform successful bag-valve-mask (BVM) airway management. Patients should be in the supine position, neck in a neutral position and the occiput slightly elevated (on a folded blanket, sheet, small pillow, etc.) to achieve a "sniffing position," with the opening of the ears at the same level as the sternal notch. Masks should be of the proper size and should be fitted to the face to obtain a seal. This is best achieved by first placing the tapered portion of the opening of the mask over the bridge of the nose, then covering the patient's mouth. If using the one-person method, the non-dominant had should use the "C & E" method with the thumb and index finger forming a C to cover the mask, and the middle, ring and small fingers forming an E on the bone of the mandible effectively lifting the jaw into the mask (rather than pressing the mask onto the face).

The other hand should gently squeeze the bag delivering a breath at a rate of one squeeze every 5-6 seconds. There should not be a leak around the mask, and you should be able to observe the rise and fall of the patient's chest. An $ETCO_2$ monitor may be placed in-line with the bag and mask. PEEP should be used with the BVM and initially set to 5mmHg. Every attempt should be made to maintain a seal to ensure continued PEEP. If the patient is breathing spontaneously, careful observation and delivery of an assisted synchronous breath should be a priority.

Some additional considerations are below:

1. If unable to perform adequate single hand C & E clamp, use two handed technique with a second person to bag.
2. Don't press mask down onto face when performing C & E clamp, visualize you are lifting face into mask.
3. Be aware fingertips on "E-clamp" should be positioned on the bones of the mandible and not on soft tissue, which could possibly occlude the airway.
4. Use "BOOTS" to predict difficult face-mask seals: Bearded, Obese, Old, Toothless, Snoring. In addition, maxillofacial trauma and edema from burns may prevent effective ventilation by BVM.
5. NPA should be used to assist with face mask ventilations (unless obvious contraindications such as mid-face trauma). OPA are also effective in obtunded patients or those who have received chemical sedation or neuromuscular blockade.
6. For bearded patients, lubrication of mask may assist seal. Tegaderm occlusive dressings over beard may also help if available. (If Tegaderm is used in sedated patient, consider pulling off before medication wears off, to lessen pain).
7. Consider mask straps to make face-mask seal more "hands free", especially if a non-medic is assisting you with BVM.

APPENDIX D: SUPRAGLOTTIC AIRWAY PLACEMENT

SUPRAGLOTTIC AIRWAY (SGA) PLACEMENT CHECKLIST

- ☐ Open airway manually, measure and insert simple airway adjunct (NPA -or- OPA).
- ☐ Ventilate patient with bag-valve-mask (BVM) (attach supplemental oxygen, if available).
- ☐ If ventilations insufficient, or the patient is clearly unconscious and not breathing adequately, prepare for supraglottic airway insertion. Inspect SGA to ensure appropriate size. Lubricate airway to facilitate passage. Cricothyroidotomy kit should be prepared for use if SGA fails.
- ☐ Follow MSMAID and for induction, use ketamine (1-2 mg/kg IV/IO or 3-4mg/kg IM) if time permits and the recommended medications are available.

INSERTING THE AIRWAY:

- ☐ Properly position head in a neutral or "sniffing" position (neck extended, as on a pillow or small blanket while lying flat) and open airway.
- ☐ Remove oropharyngeal airway (OPA) if previously placed.
- ☐ Insert device to proper depth (may adjust later if need for improved ventilation).
- ☐ Inflate cuff, if applicable; inflate as per device-specific volume instructions and immediately remove syringe.
- ☐ Confirm placement with ventilation and auscultation over epigastrium, then bilaterally over chest, left lung then right lung. Get a second practitioner to double check and verify in sounds are questionable or cannot otherwise auscultate.
- ☐ Verify proper SGA placement by secondary confirmation such as capnography/capnometry or colorimetric device.
- ☐ Place orogastric tube and decompress stomach if available, and compatible with SGA device (has a port specifically for OGT placement).

SGA Size Chart

Estimated patient size	LMA	King LT*
Neonates/Infants (up to 5kg)	1	0
Infants 5-10 kg	1.5	1
Infants/Children 10-20kg	2	2
Children 20-30kg	2.5	2.5
Children 30-50kg	3	3*
Adults 50-70kg	4	4*
Adults 70-100kg	5	5*
Adults over 100kg	6	

APPENDIX E: CRICOTHYROIDOTOMY PROCEDURE CHECKLIST

PREPARE PATIENT

1. Pre-oxygenate patient if possible.
2. Inspect/assemble/test equipment for cricothyroidotomy.
3. Prepare site with alcohol and betadine -or- Chlorhexadine (Chlora-prep).
4. Follow MSMAID and for induction, use ketamine (1mg/kg IV/IO or 3-4mg/kg IM) if time permits and the medication is available.

For awake cricothyrotomy: Explain procedure to patient; *Use local anesthesia: lidocaine (1% or 2%), bupivacaine (0.25%, 0.5% or 1%); local through planned incision area AND approx. 1-2mL through cricothyroid membrane

PERFORM PROCEDURE

1. Stabilize thyroid cartilage and keep overlying skin taught. Maintain control with hand until the membrane incision is secured (step 8 below).
2. Locate cricothyroid membrane (Palpate for hyoid and tracheal rings. If unsure or difficult landmarks, then measure three finger widths above sternal notch for adults).
3. Make vertical incision through the skin over cricothyroid membrane.
4. Make horizontal incision through cricothyroid membrane, then immediately:
5. Open and maintain membrane incision with tracheal hook (or curved hemostat, bougie or blunt end of scalpel).
6. Insert endotracheal/tracheostomy tube into opening and direct tube caudad into trachea until the balloon is just inside the airway.
7. Inflate cuff and detach syringe (palpate bulb to ensure it's not under-inflated or over-inflated).
8. Maintain control of tube at all times to prevent dislodgement.
9. Attach waveform capnography, or capnometry, or colorimetric device to confirm proper placement of tube.
10. Being careful not to dislodge the tube, attach BVM with PEEP and further check placement (epigastric and bilateral chest) and adequacy of bilateral insufflation of lungs.
11. Remove BVM (if sufficient respiratory effort), assess respirations for adequacy (rate, rhythm, and quality), assist ventilations if needed.
12. Secure with sutures and tie with girth hitch passed around the neck if time permits. As a stopgap, may use chest seal or secure around the neck with tie, ensuring inflation bulb does not get caught.
13. Consider placing NG/OG tube if available.

APPENDIX F: POST CRICOTHYROTOMY/ENDOTRACHEAL INTUBATION CHECKLIST

POST CRICOTHYROTOMY/ENDOTRACHEAL INTUBATION CHECKLIST

- ☐ Double check placement with waveform capnography or capnometry, placed directly on ET tube adapter.
- ☐ Check proper tube depth (not main stem) by auscultating bilateral lung sounds
- ☐ Check that tube is secured (suture to skin + tie with girth hitch around neck, should be able to fit 2 fingers under the tube tie)
- ☐ Bag-valve-mask (BVM) with positive end-expiratory pressure (PEEP) valve @ 5 of PEEP at proper volume (one hand moderate squeeze) and proper rate (one squeeze every 5-6 seconds)
- ☐ Provide adequate analgesia and sedation (follow analgesia and sedation CPG)
- ☐ Calculate remaining medication and establish analgesia and sedation plan. A patient with a cricothyroidotomy may not require heavy continuous sedation.
- ☐ Raise the head and torso to 30 - 45°
- ☐ Filter and humidify the air with a heat moisture exchanger. Place HME in-line distal to $EtCO_2$ device.
- ☐ As needed, place in-line suction for the tube, and suction the mouth for any excess secretions
- ☐ Check cuff pressure (palpate bulb – should be moderately firm but still compressible)
- ☐ Place orogastric tube, if available.
- ☐ Put a BVM +PEEP valve at the bedside if using a mechanical ventilator.
- ☐ Decontaminate the mouth with chlorhexidine swab or toothbrush without paste as per the nursing care plan.

APPENDIX G: WAVEFORM CAPNOGRAPHY & PULSE OXIMETRY INTERPRETATION

WAVEFORM CAPNOGRAPHY (END TIDAL CO2 ($ETCO_2$)) AND PULSE OXIMETRY (SPO2) INTERPRETATION

Detection of $ETCO^2$ is the most reliable way to continuously monitor ventilation and therefore confirm placement of an advanced airway (the only exception is during CPR when $ETCO_2$ may be undetectable). Waveform capnography is the preferred method to detect $ETCO_2$, and with the development of small, portable devices, is the recommended technique even in austere field environments. Inexpensive colorimetric CO_2 detectors are available, however the color change method may be very difficult to visualize with poor lighting or night vision devices. Waveform capnography measures the end-tidal carbon dioxide that passes through the device as the patient exhales in real time since it is placed directly in-line with the endotracheal tube. $ETCO_2$ may also be attached to a face mask to verify normal and spontaneous breaths if an advanced airway has not been placed. With most portable, field capnographs, a number in mmHg will be appear on the display, which indicates the value of the CO_2 in the exhaled breath and can be an immediate confirmation of correct tube placement. If the airway was placed correctly, and the patient is ventilating normally, the capnograph should read between 35-45 mmHg. Some other examples include:

- $ETCO_2$ = 0: the tube is not transmitting any CO_2: disconnected, tube placed in wrong position or has become dislodged. This may also occur if the patient is dead and there is no gas exchange.
- $ETCO_2$ <35: Hyperventilation. The most common cause is over-bagging the patient, but may also indicate pain or anxiety. The only indication for "induced" hyperventilation is severe traumatic brain injury with signs of acute herniation, GOAL = 30-35 (no less than 30)
- $ETCO_2$ >45: Retaining CO_2, ineffective ventilation may indicate oversedation, primary lung problem, brain injury, worsening obstructive disease (asthma). If the trend is rising, this is an indicator of need for active ventilation assistance (BVM or mechanical ventilator)

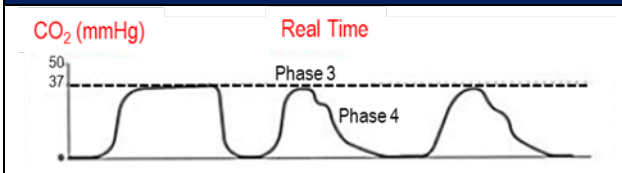
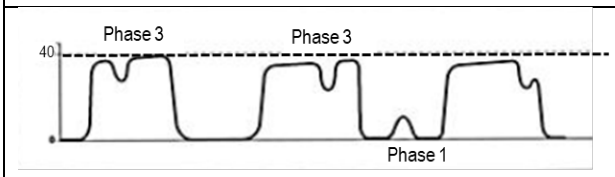
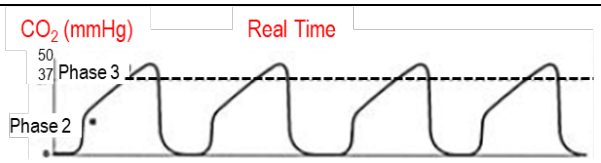
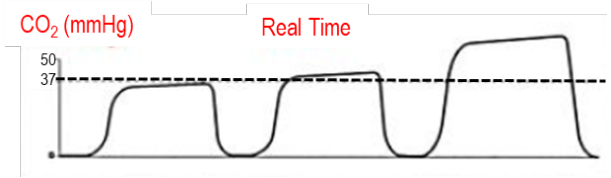
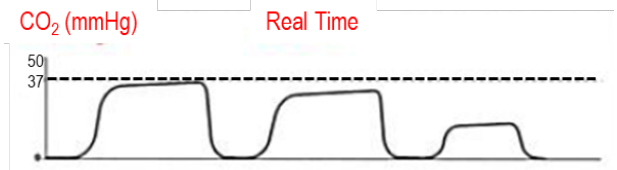
During CPR (as an indicator of effectiveness of chest compressions and return of circulation):

- $ETCO_2$ < 10: there is no return of CO_2 to the lungs (no effective circulation). If CPR is initiated, it is ineffective
- $ETCO_2$ = 10-20: EFFECTIVE CPR
- $ETCO_2$ = 40 OR GREATER: You may see an abnormally high CO_2 reading immediately after return of spontaneous circulation (ROSC), for instance after a successful defibrillation or return of effective cardiac activity.

Monitor that can provide waveform capnography can provide much more insight into a patient's ventilation and oxygenation status. A quick reference to the most common waveforms is helpful to understanding the status of a patient.

Pulse oximetry is also of use in monitoring the oxygenation status of a patient. It can be an indirect measure of oxygen delivery to the tissues, and overall pulmonary function. Pulse oximetry monitors oxygenation by measuring absorbance differences between oxyhemoglobin and deoxyhemoglobin through the use of an infrared light. Pulse oximetry, however, has some important key limitations. A pulse oximetry reading indirectly reflects the patient's central (pulmonary) oxygenation status by measuring the peripheral oxygenation. This means that any intervention that addresses oxygenation in the lungs may not be detected by the pulse oximeter until 30-90 seconds after the intervention.

Additionally, if the patient is suffering from carbon monoxide or some other forms of poisoning, the pulse oximetry may read inaccurately. Also, a strong peripheral pulse and warm extremity are required to perfuse the capillary beds of the extremities and allow the pulse oximeter to obtain a valid measurement, therefore it may be difficult to measure in cold or hypotensive patients.

CAPNOGRAPHY (ETCO2) WAVEFORM	CHARACTERISTICS	CONSIDERATIONS
	**Cuff Leak** Waveform degrades sharply	• Check ET Tube for leak and replace as necessary (recommend exchange over a bougie)
	**Curare Cleft** Cleft or notch in waveform	• Represents asynchronous ventilation • Reassess patients level of sedation and augment as needed
	**Obstruction** Classic shark fin pattern	• Represents bronchospasm or airway obstruction • Assess for Hx of asthma, kinked ET tube, foreign body in airway or other anatomical airway obstruction.
	Loss of Waveform Normal waveform and then no waveform	• Assess for total airway obstruction, apnea, or cardiac arrest. • Assess ET tube for dislodgement and/or the need for suction • Check equipment for failure
	**Increasing $ETCO_2$** Waveform increases in amplitude and width	• Assess for insufficient respirations, if breathing spontaneously, and treat underlying cause • Assess for respiratory failure • Assess for temperature increase • Consider increasing minute ventilation • Note: TQ release and sodium bicarbonate may cause a temporary increase in $ETCO_2$
	**Decreasing $ETCO_2$** Waveform decreases in amplitude and width	• Assess for tachypnea and treat underlying cause, if patient breathing spontaneously, • Assess for pulmonary embolism (If possible)

APPENDIX H: PEDIATRIC CONSIDERATIONS

PEDIATRIC CONSIDERATIONS FOR MSMAID & AIRWAY MANAGEMENT

MSMAID:

Similar to adult patients, the same preparatory steps should be followed prior to pediatric airway intervention. There are, however, significant differences with respect to equipment requirements and provider skill level. The core principles of MSMAID remain the same, with the following considerations:

- **Machine** – Continuous ventilation requires specific rate and volume based on the patient's age/size. Ensure your equipment (ventilator) and/or BVM can provide the required rate and volume prior to intubating or performing advanced procedures.[1,2]
- **Suction** – Similar to adults, ideally you can provide in-line suction, but you also will at a minimum need the correct size tubes to be able to provide suction
- **Monitor** – having pediatric sized equipment is essential as well as being able to adapt to pediatric sizes using adult monitors
- **Airway** – Multiple sizes of tubes are essential and proper pre-mission logistic planning includes pediatric supplies
- **Intravenous access** – Ensure you have pediatric sized needles with 24, 22, 20 and 18g as the primary access based on age of the patient. Pediatric intraosseous needles may be required.
- **Drugs** – Ensure you have a drug estimation guide, but always double check pediatric weight-based doses and measurements.

ADDITIONAL EQUIPMENT

1. Broselow Tape or similar height-based treatment aids.[3]
2. Video Laryngoscopy (VL) –VL has been shown in studies to out-perform direct laryngoscopy in pedatric airways.[4-7]
3. Pediatric Kit – Pediatric airway equipment should be pre-packaged and set apart to allow for a rapid inclusion or addition to baseline airway kits.

ESSENTIAL MEASUREMENTS AND FORMULAS

Unlike adult airways that are narrowest at the level of the vocal cords (and therefore visible during DL or VL) pediatric tracheas are narrowest at the infraglottic level (19). In consideration of this, the following formulas and treatment aids are presented to best estimate tube sizes and measurements:

1. ETT size: age/4 +3.5. [8]
2. ETT insertion depth (for children over 1 year of age) in centimeters: age/2 + 13
3. ETT insertion depth (for children under 1 year of age) in centimeters: weight/2 + 8
4. Tidal volume: 5-8 cc/kg, rate concordant with pre-arrest breathing or rate prior to intervention. PALS recommends initial rate of at least 10-12 breaths/minute.[1,2]
5. Use caution with BVM, especially if improvising with adult BVM. Inflate gently only until the chest begins to rise. Surgical Airway Management

LMAs should be the first choice in all children prior to consideration of surgical intervention. Surgical airways should NOT be attempted on children younger than 12 years of age given the maturity of the

thyroid cartilage and the cricothyroid membrane. It should never be attempted in children where the thyroid cartilage cannot be palpated. For children needing advanced airway intervention younger than 12 years of age, a combination of bag-valve-mask ventilation or placement of a supraglottic airway is recommended.[9,1]

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APPENDIX I: AIRWAY MANAGEMENT (USING MSMAID) IN PROLONGED FIELD CARE: SUMMARY TABLE

GOAL/CAPABILITY	MINIMUM	BETTER	BEST
MACHINE: Equipment needed post-intubation	Bag-Valve-Mask (BVM) with PEEP valve	• Automated portable ventilator (preferably with PEEP) • Oxygen concentrator	• Full-feature portable ventilator (e.g.; several ventilatory modes, PEEP) • Supplemental oxygen if available
SUCTION	• Improvised suction, such as using syringe + nasopharyngeal airway (NPA) • Patient positioning if not contraindicated	• Manual suction bulb with adapter	Powered commercial suction with oral tip In-line endotracheal tube suction adapter
MONITOR: Monitoring and telemedicine support	• Pulse oximeter (SpO2) • Assistant to monitor respirations and record manual vital signs • Trending vital signs documentation • Voice or data connections to perform telemedicine communication	• Portable Capnometry ($ETCO_2$) /capnography in addition to SpO2 • Transmit photographs from smartphones or personal devices to augment telemedicine communications	• Automatic vital signs monitor with SpO2, $ETCO_2$/waveform capnography, +/- electrocardiogram (EKG) • Synchronous (real-time continuous) telemedicine using video or remote patient monitoring systems
AIRWAY	Ketamine cricothyroidotomy	Add ability to provide continuous sedation	Add a responsible rapid-sequence intubation capability (to include chemical paralysis) with airway maintenance (to include suction) and continuous sedation
AIRWAY: Verify proper tube placement	• Visualization of the tube passing through the vocal cords (in the case of endotracheal intubation) • Auscultation of epigastric region (should be silent) and bilateral lung sounds (should be present) • Colorimetric capnography + endotracheal detection device (EDD) • Easy bilateral rise and fall of the chest + misting of the tube + no signs of gastric insufflation	• Minimum plus portable capnometer • Ultrasound if trained/available to guide and/or verify placement	Continuous $ETCO_2$/waveform capnography
IV/IO ACCESS	• If IV/IO attempts fail or when unavailable: medication may be given intramuscularly or intranasally for immediate sedation to facilitate surgical cricothyroidotomy • Continue attempts at IV/IO access after airway has been controlled	1-2 patent IV/IO	2-3x patent intravenous (IV) / intraosseous (IO) with additional IO device on standby

GOAL/CAPABILITY	MINIMUM	BETTER	BEST
DRUGS: Airway placement	• Local anesthetic for cricothyroidotomy (superficial skin anesthesia plus 1-2 mL injected through the cricothyroid membrane) • Placement without medications in unconscious patient • Also: most sedating agents can be given IM if IV/IO has not been established	Any IV/ IO sedating agent (i.e. opioid, benzodiazepine)	• Procedural dose ketamine (1-2 mg/kg IV push) for ETT or cricothyroidotomy placement • Local anesthetic (lidocaine) for cricothyroidotomy placement
DRUGS: Prolonged sedation (post-placement)	No I.V. access: ketamine (sedation dose), 3-4mg/kg IM	IV/ IO pushes of ketamine, opioid, and/or midazolam (alone or in combination as per the individual's scope of practice, experience and availability of medications)	• Ketamine I.V./ IO Drip • Hydromorphone or alternate opioid IV/IO push for breakthrough pain • Midazolam IV/IO push as needed for sedation
Airway Equipment	• Nasopharyngeal airway • Cricothyrotomy kit • BVM with PEEP valve	• Minimum PLUS supraglottic airway • Gum elastic bougie to facilitate intubation • Nasogastric/orogastric tube	• Better PLUS endotracheal tubes • Video laryngoscopy equipment preferred (direct laryngoscope only if video equipment not available).
Waveform Capnography	Colorimetric $EtCO_2$ detector	Portable capnometer	Waveform capnography on patient monitor

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APPENDIX J: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Airway Management of Traumatic Injuries

To optimize the airway management for patients with traumatic injury in the operational medical treatment facility environment.

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01 Sep 2023 Update: DEVICE data regarding video laryngoscope.

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BACKGROUND

Airway obstruction was the second most common cause of potentially survivable death in all US combat casualties from October 2001 to June 2011. Thus, airway management is often a critical early step in the resuscitation of the severely injured trauma patient. Identifying harbingers of a potentially difficult airway, having knowledge of a difficult airway algorithm, and understanding the proper utilization of alternative airway devices will allow for a pre-planned strategy for successful airway management.

SIGNIFICANT CHANGES

Refer to in Appendix A for Trauma Airway Assessment guidance and Appendix B for Difficult Airway Management.

1. Ketamine is the first line agent for Rapid Sequence Intubation (RSI).
2. Apply principles of Apneic Oxygenation.
3. Utilize device name rather than brand-name wherever possible.
4. Eliminate blind nasal intubation. Anticipate fiber optic guidance if available.
5. Use waveform or digital capnography as primary tool to verify tube placement if available.
6. Remove recommendation for use of an intubating Laryngeal Mask Airway.
7. Offer surgical cricothyroidotomy or tracheostomy as surgical airway options.
8. Optimize RSI and Intubation Pathway for all patients. Separate Traumatic Brain Injury (TBI) algorithm not required.
9. Include specific pediatric recommendations.
10. Trauma airway management should be rehearsed with your trauma team on a regular basis to include role assignments and familiarization with difficult airway management and surgical airway equipment.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients who received ETT/cricothyroidotomy/supraglottic airway/NPA
- All patients with compromised airway (initial GCS < 8 or AIS head and neck ≥ 3 or AIS face ≥ 3, arrival/transport or initial ED SpO2 < 90%, arrival/transport or initial ED ETCO2 > 50).

INTENT (EXPECTED OUTCOMES)

- All injured patients who present with obtundation (GCS<8), apnea, respiratory distress or insufficiency, airway obstruction, or impending airway loss will have a secure and definitive airway established expeditiously upon arrival to a Role 2 or Role 3.
- SpO2 is maintained between ≥ 90% and 96%. SpO2 >96% is not necessary.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who had a secure and definitive airway (endotracheal tube, cricothyroidotomy, tracheostomy) established or verified on arrival to Role 2 or 3, or documentation of appropriate intervention.

2. Number and percentage of patients in the population of interest with initial ED SpO2 < 90%, < 80%, <70%, <60%.

3. Number and percentage of patients who had definitive airway (endotracheal tube, cricothyroidotomy, tracheostomy) with ETCO2 documented at the same role of care where the procedure is done.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional performance improvement monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by JTS Chief and the JTS PI Branch.

RESPONSIBILITY

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

All Health Care Providers

1. Will be familiar with the guidelines for performance of trauma airway management.
2. Will be familiar with the guidelines for performance of rapid sequence intubation.
3. Will be familiar with alternative airway devices mentioned in guidelines for trauma airway management.
4. Will provide feedback and suggested CPG changes to the JTS Chief and/or Program Manager.

The Chief, Emergency/Anesthesia/Surgery

At each Level III facility, the chief will coordinate with the JTS Chief on the appropriateness of the guidelines being used and provide input for updates on an as needed basis.

The JTS Chief

1. Will be the subject matter expert on the trauma airway management CPG to be used in the US Central Command Area of Responsibility.
2. Will review annually and update the CPG as needed.

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APPENDIX A : TRAUMA AIRWAY ASSESSMENT

Trauma Airway Management

Airway Assessment

- All trauma airways are potentially high-risk. Anticipate a difficult airway.
- Identify critical team members and verbalize role assignments.
- Initiate pre-oxygenation (1,2).
- Consider Ketamine (0.5-1.0 mg/kg IV/IO) for delayed sequence intubation if combative or otherwise uncooperative patient (3,4,5).
- Recall that the neutral position ("C-spine stabilization") degrades the laryngoscopic view.

Rapid Sequence Induction (RSI) and Intubation Pathway

1. **Confirm equipment availability and function.**
   IV/IO, suction, self-inflating bag and mask, oxygen source, laryngoscope- video (preferred) or direct (if video not available) (5, 20), ETT with stylet and/or gum elastic bougie, oral & nasal airways, surgical airway kit, drugs, C02 detector, monitors, other rescue equipment
2. **Pre-Oxygenate (Denitrogenate) the lungs (1,2,6)**
   - Prolongs tolerance of apneic period
   - Goal is ≈ 3 minutes of tidal volume breathing at 90% FiO2.
   - With standard reservoir facemask set flow rate of oxygen as high as possible
   - Recommend augmenting with nasal cannula at 15L/min oxygen in preparation for apneic oxygenation, leave in situ throughout procedure (2,8)
   - Elevate head of bed if not contraindicated.
3. **Maintain cervical spine stabilization.**
4. **Remove front of cervical collar**
5. **Consider cricoid pressure simultaneous w/ medication administration (9,10)**
6. **Administer medications :** Initiate RSI

Sedative/hypnotic

- Ketamine (1st Line): 2 mg/kg IV/IO
- Etomidate (2nd Line): 0.3 mg/kg IV/IO

Unstable patients require reduced dosage of induction agent.

Neuromuscular Blockade

- Rocuronium: 1.2 mg/kg IV/IO or
- Vecuronium: 0.1 mg/kg IV/IO or
- Succinylcholine: 1.5 mg/kg IV/IO

7. **Perform laryngoscopic tracheal intubation.**
   - Following onset of neuromuscular blockade
   - Recommend gum elastic bougie as primary ETT stylet.
8. **If laryngoscopic view is poor:**
   - Apply external laryngeal manipulation technique(s)
   - Consider alternative visualization method or Supraglottic airway device.
9. **Confirm tracheal intubation.**
   - Visualize tube passing between the vocal cords (First Line)
   - Wave form or digital capnography when available (Second Line)
   - Easy chest rise, equal axillary breath sounds/absence of gastric insufflation, CO2 Calorimeter, and "fog" in ETT
   - Esophageal detector bulb or fiber optic confirmation during cardiac arrest
10. **Provide continuing care IAW Anesthesia CPG**

Recommendations for Pediatric Patients

1. Train to expect pediatric patients. Have a dedicated pediatric airway cart, including Broselow tape or equivalent.
2. Pre-dose with atropine IV/IO (0.02mg/kg, minimum dose 0.1mg, maximum dose 0.5mg) in all <1 years old, those <5 who are receiving succinylcholine, and in all who receive a 2nd dose of succinylcholine.
3. Induction -
   - Ketamine (first line) 2mg/kg IV/IO
   - Etomidate (second line) 0.3mg/kg IV/IO
4. Neuromuscular blockade -
   - Succinylcholine 1.5mg/kg IV/IO (2mg/kg <5 years old) or
   - Rocuronium 1mg/kg IV/IO
5. Avoid surgical airway in <12 years old - use needle cricothyroidotomy (12-14 gauge), tracheostomy preferred over surgical cricothyroidotomy

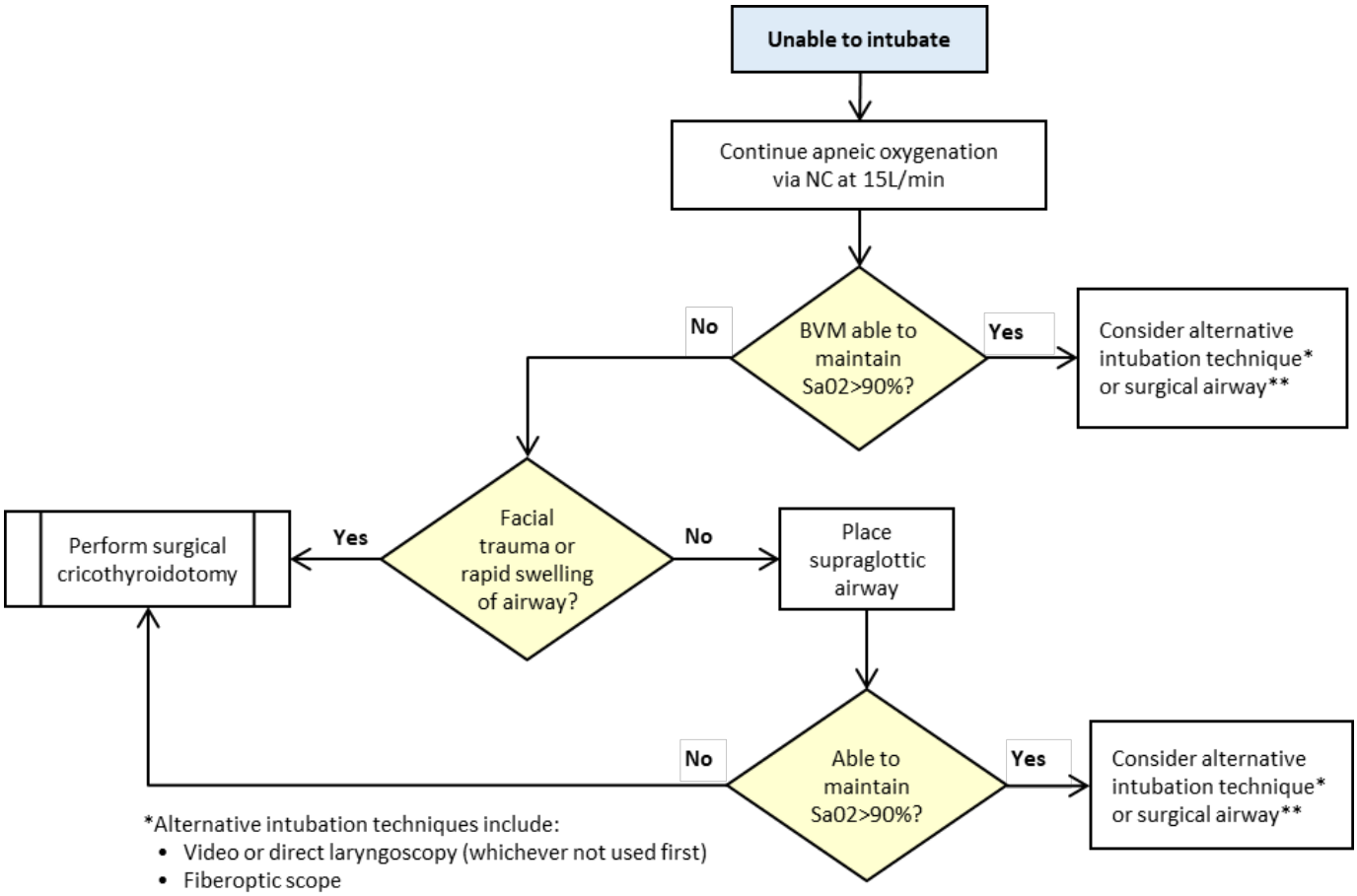
Unable to Intubate: Can You Mask Ventilate?

Mask Ventilation Pearls

- Skilled operator
- Good seal
- Jaw thrust
- Oral airway
- Nasal airway(s)
- Two operator mask ventilation

YES	• Improve position, change blade/operator, laryngeal manipulation technique, gum elastic bougie. • Attempt alternate technique: Fiber optic, video laryngoscope, tracheal trans illumination device. • More than ≈ 3 attempts at intubation may abolish your ability to mask ventilate due to edema caused by laryngoscopy. • Surgical airway (Cricothyroidotomy or tracheostomy)
NO	• Emergency pathway...seconds matter. • Supraglottic airway or • Surgical cricothyroidotomy

APPENDIX B: DIFFICULT AIRWAY MANAGEMENT ALGORITHM



*Alternative intubation techniques include:

- Video or direct laryngoscopy (whichever not used first)
- Fiberoptic scope
- Transtracheal illumination device
- Retrograde wire with Magill forceps
- Changing providers

**Surgical airway includes both tracheostomy and surgical cricothyroidotomy will be performed.

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Amputation: Evaluation and Treatment (CPG ID: 07)

To provide standardization of optimal care for the performance of wound management and life-saving amputations that will ensure preservation of maximum limb length, promote healing of viable tissues, and facilitate optimal rehabilitative function.

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BACKGROUND

The extent of the "zone of injury" is dependent upon the mechanism of injury (i.e. blast, gunshot and crush injuries), as well as the co-morbidities and physiologic status of the casualty. Factors such as severe blood loss with massive resuscitation, burns, compartment syndrome, tourniquet use, and contamination load often extend the actual amount of tissue damage beyond that which is apparent on initial visual inspection.[1] Amputation terminology includes traumatic amputations which are immediate extremity amputations caused by the wounding mechanism itself. Primary amputations are those performed by a surgical team after evaluation of the mangled extremity, with the decision not to pursue limb salvage for whatever reason. Secondary amputations can occur early (within 90 days) or late (after 90 days), with the latter referring to those amputations occurring after an initial attempt at limb salvage has been undertaken. Most commonly, primary and early secondary amputations are performed for vascular injuries not amenable to repair or resulting in prolonged limb ischemia, nerve injuries not compatible with a functional extremity, or extensive nonviable tissue with potential for uncontrolled sepsis. Late secondary amputations are generally performed due to patient preference or major complications (e.g., flap failure, recurrent osteomyelitis, persistent poor function or pain) of attempted limb salvage. Current consensus regarding extremity amputation following battle-injury is to preserve limb length and vascularity, facilitate adequate wound drainage, and achieve eventual coverage and closure of the amputation wound.[2]

DECISION TO AMPUTATE

Although a number of scoring systems to predict the need for amputation exist,[3] none is widely accepted or validated in the combat trauma population. Intact or the potential to restore perfusion (by vascular repair or shunt) may be the first determinant. If perfusion can be restored, any decision regarding amputation for nerve or bone loss can potentially be deferred until later, with the structurally unstable limb for transport by splinting or external fixation. Given the time sometimes required to restore perfusion, amputation may be necessary and a Damage Control procedure in a massively injured patient.

EVALUATION AND TREATMENT

1. Thorough **inspection of the wounds** with liberal use of surgical wound extension is necessary to inspect all levels of tissue including examination of fascial planes. If available, continuous wave Doppler examination and diagnostic arteriography can be used as adjuncts in cases where distal perfusion is a concern.[4]

2. **After early control of active hemorrhage** is achieved, gross decontamination, followed by a meticulous sharp debridement using a scalpel and/or scissors should be a starting point for nearly all wartime penetrating wounds. Removal of all nonviable tissue, including skin, fat, fascia, muscle, and bone, is essential to reduce the load of contamination and necrotic tissue in the wound and is the hallmark of an adequate debridement. The adjunct of irrigation or lavage with normal saline is also important to decrease bacterial count and soiling. This can be accomplished using various devices such as pulse lavage using a battery powered system or gravity irrigation using genitourinary tubing or bulb/syringe. Published clinical data is inconclusive as to which irrigation method is superior (see Initial Management of War Wounds JTS CPG for additional information). Assurance of hemostasis is important prior to evaluation for dressing or closure.[5]

3. **In the setting of an extremity amputation**, appropriate vascular structures should be ligated proximal to the bone resection but as distal as possible to ensure adequate tissue perfusion. Vascular structures should be separated from nerves prior to ligation.

4. **The amputation should be performed at the most distal level which provides viable bone and soft tissues for later closure**. In select instances close to the proximal joint (e.g. knee, elbow), preservation of viable bone length in the absence of adequate viable soft tissue coverage is advocated in order to preserve options for either late free tissue transfer coverage and amputation level salvage or disarticulation. Ipsilateral fractures proximal to the level of viable tissue should be initially stabilized and should not be a determining factor for amputation level. These fractures can be stabilized with external fixation, splinting, or pins to facilitate evacuation.[6]

5. Be prepared to **accept atypical skin and tissue flaps** so long as the tissue is viable.

6. **Do not perform primary closure of traumatic amputations.** All wounds must be left open and re-evaluated with serial irrigation and debridement's as the zone of injury declares itself.

7. **Avoid open circular or guillotine amputations.** These techniques are antiquated, sacrifice viable soft tissue and relegate the casualty to more proximal revision, and are not that much faster than the open, length-preserving length of initial amputation advocated. All amputations should be performed at the most distal level practicable with re-evaluation of the open amputation site within the first 24 hours.[7,8]

POST-OPERATIVE MANAGEMENT

1. **Soft dry dressing should be applied around the amputation site and extremity**. Circumferential wraps with gauze rolls and ace wraps must be applied in a figure of eight fashion without excessive compression.

2. The limb **may be placed in a splint or bivalve cast** to prevent joint contractures and provide soft tissue support when necessary. There should be simple access for wound inspection.

3. In the **event of the short skin flaps**, skin traction to prevent soft tissue retraction is an option.

4. **Avoid placement of pillows under the knee** so as to prevent contractures when dealing with amputations below the knee.

5. **Negative Pressure Wound Therapy (NPWT) device using Reticulated Open Cell Foam (ROCF)** material, have recently been shown to be an alternate strategy and valuable adjunct in the overall management of amputation wounds.[9] The Vacuum Assisted Closure (VAC) device has been the primary NPWT device used within the DoD. Recent clinical studies support the use of the VAC as a soft tissue wound management adjunct in appropriately prepared wounds as a bridge to delayed closure, flap coverage, or coverage with a split thickness skin graft. In appropriately debrided and prepared wounds the VAC has been shown to increase the rate of granulation and decrease bacterial colonization leading to effective amputation coverage and or closure.[10] Use of NPWT/ROCF should be considered only after complete wound debridement and hemostasis have been achieved. The VAC ROCF sponge should cover the open wound bed and be set to -125 mm Hg continuous pressure.[4]

   NOTE: *Use of VAC dressings has recently been demonstrated to be safe in patients during strategic aeromedical evacuation.*

   The efficacy and long-term sequelae of NPWT/ROCF is not yet fully established, however; current clinical experience has been largely favorable. Surgeons who elect to employ this wound coverage method as part of their overall wound management strategy should be thoroughly familiar with the VAC system and its correct use.

6. There are **disadvantages to the use of NPWT** in the management of combat-related amputations: they are bulky for transport and can easily occlude or leak, resulting in ineffective therapy or the machine

shutting down automatically during transport. Additionally, NPWT can macerate tissue, obliterate soft tissue planes, and there is concern for a potential role in the pathogenesis of heterotopic ossification.

7. **NPWT/ROCF dressings can be left in place for 24 to 48 hours** depending upon the extent and acuity of the wound. More extensive and acute soft tissue wounds should have the VAC dressing removed with further irrigation and debridement on shorter intervals (every 24 hours) compared to less extensive wounds (greater than every 24 hours). Initiation of delayed primary closure from the ends of the wound may be started during these repeat debridements and irrigation with re-application of smaller VAC dressing sponges.

8. **Coordinate dressing changes/repeat debridement with evacuation schedule** to avoid extended periods without wound care or inspection. Given the extent of many soft tissue wounds dressing changes and repeat debridements should be performed in the operating room affording the patient the comfort of conscious sedation or general anesthesia and the surgeon access to the full array of equipment necessary to perform adequate debridement. Also, reapplication of the VAC dressing may be more complete and effective if performed in the operating room with the support of operating room and anesthesia teams.

AEROMEDICAL EVACUATION CONSIDERATIONS

Due to the requirement to move the coalition patient with traumatic amputation to Role 4 facilities usually out of theater, early and safe transport of these patients should involve consideration of the following factors.

1. **Concomitant injury management** is crucial during flight. Additional orthopedic injuries should be stabilized and structurally sound for transport. Limbs should be splinted and positioned to decrease the possibility of post traumatic contractures.

2. If **adequate tissue perfusion** is a concern, supplemental oxygen should be given to increase oxygen tissue delivery.

3. **Large wounds or wound vacuums** can add an area of increased heat loss. Take preventative measures to reduce risk of hypothermia.

4. **Flight stresses** include movement and vibration which can increase pain during transport. It is likely that pain medication requirements will increase during these times. Evaluate analgesia protocols as well as the patient's analgesia needs and response to pain medications.

5. ***Do not remove drains or wound vac*** in the immediate period prior to aeromedical evacuation. Coordinate dressing change timing with the patient movement schedule.

6. **Patients with multiple trauma** require Deep Vein Thrombosis prophylaxis if anatomically feasible and not contraindicated. Refer to The Prevention of Deep Vein Thrombosis-Inferior Vena Cava Filter CPG, 02 Aug 2016 (ID:36) for specific guidance.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with diagnosis of limb amputation or limb amputation procedure code.

INTENT (EXPECTED OUTCOMES)

1. Amputation wounds are not closed at the initial operation
2. Circular/guillotine amputation is avoided (viable soft tissue is preserved).
3. Repeat debridement/dressing change within 48 of first debridement/amputation procedure.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have amputation wounds left open at initial operation (closed flap amputation at first procedure = non-adherence).
2. Number and percentage of patients in the population of interest who have documentation that all viable soft tissue is preserved at the initial operation.
3. Number and percentage of patients in the population of interest who have their dressing change/repeat debridement in <48 hours of initial amputation/procedure.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

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Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Analgesia and Sedation Management during Prolonged Field Care

The intent of this guideline is to identify potential issues one must consider when providing analgesia with or /without sedation for an extended time. This guideline begins where Tactical Combat Casualty Care (TCCC) guidelines end.

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PURPOSE

This Role 1, prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines, when evacuation to higher level of care is not immediately possible. A provider of PFC first must be an expert in TCCC. The intent of this guideline is to identify potential issues one must consider when providing analgesia with or without sedation for an extended time (i.e. 4–72 hours). As a principle, the guideline attempts to decrease complexity by reducing options for monitoring, medications, and so forth. It prioritizes experience with a limited number of options rather than providing recommendations about many different options that can be used in a more customized way. It does not address induction of anesthesia before airway management (i.e. rapid sequence intubation). The CPG should be used by all clinicians providing analgesia and sedation in a Role 1 (R1) or PFC environment.

PRIORITIES OF CARE

Priorities of care as related to analgesia and sedation:

1. Keep the casualty alive. Do not give analgesia and/or sedation if there are other priorities of care (e.g., hemorrhage control).
2. Sustain adequate physiology to maintain perfusion. Do not give medications that lower blood pressure or suppress respiration if the patient is in hemorrhagic shock or respiratory distress (or is at significant risk of developing either condition).
3. Relieve pain. Give medications to treat pain first.
4. Maintain safety. Agitation and anxiety may cause patients to do unwanted things (e.g., remove devices, fight, fall). Sedation may be needed to maintain patient safety.
5. Stop awareness. During painful procedures, and during some mission requirements, amnesia may be desired.

PRINCIPLES

- In an R1 or PFC setting, intravenous (IV) or interosseous (IO) medication delivery is preferred over intramuscular (IM) therapies. The IV/IO route is more predictable in terms of dose-response relationship.
- Remember, you can always give more, but it is very difficult to take away. Therefore, it is easier to prevent cardiorespiratory depression by being patient and methodical. **Titrate to effect**.
- Smaller, more frequent doses of medications are preferred to single large doses to achieve a constant level of pain control and sedation over a longer time.
- The lower the blood volume, the less drug and time will be needed to achieve similar affects as compared with a normovolemic patient. **Start low, go slow.**

Engage telemedicine support early and often if you are inexperienced in delivering analgesia and sedation beyond TCCC or if you are having difficulty.

PRINCIPLES OF MEDICATION USE IN THE PFC SETTING

Comparative effectiveness data for one analgesia/sedation strategy versus another are lacking. The principles of medication use in the PFC setting include:

1. Consider pain in three categories:

    a. **Background**: the pain that is always present because of an injury or wound. This should be managed to keep a patient comfortable at rest but should not impair breathing, circulation, or mental status.

    b. **Breakthrough**: the acute pain induced with movement or manipulation. This should be managed as needed. If breakthrough pain occurs often or while at rest, background pain medication should be increased.

    c. **Procedural**: the acute pain associated with a procedure. This should be anticipated and managed periprocedurally.

2. Analgesia is the alleviation of pain and should be the primary focus of using these medications. In other words, treat pain before considering sedation. Remember, not every patient needs (or should receive) pain medication at first, and unstable patients may require other therapies or resuscitation before the administration of pain or sedation medications.

3. Sedation is used to relieve agitation or anxiety and, in some cases, induce amnesia. The most common causes of agitation are untreated pain or other serious physiologic problems like hypoxia, hypotension, or hypoglycemia. Sedation is used most commonly to ensure patient safety (e.g., when agitation is not controlled by analgesia and there is need for the patient to remain calm to avoid movement that might cause unintentional tube, line, dressing, splint, or other device removal or to allow a procedure to be performed) or to obtain patient amnesia to an event (e.g., forming no memory of a painful procedure or during paralysis for ventilator management).

4. Each patient responds differently to medications, particularly with respect to dose. Some individuals require substantially more opioid, benzodiazepine, or ketamine; some require significantly less. Once you have a "feel" for how much medication a patient requires, you can be more comfortable giving similar amounts during redosing. In general, a single medication will achieve its desired effect if enough is given; however, the higher the dose, the more likely the side effects. Additionally, ketamine, opioids, and benzodiazepines given together have a synergistic effect: the effect of medications given together is much greater than a single medication given alone (i.e. the effect is multiplied, not added. Go with less than what you might normally use if each were given alone).

5. PFC requires a different treatment approach than TCCC. Go slow, use lower doses of medication, titrate to effect, and redose more frequently. This will provide more consistent pain control and sedation. High doses may result in dramatic swings between oversedation with respiratory suppression and hypotension alternating with agitation and emergence phenomenon.

MONITORING

Patients receiving analgesia and sedation require close monitoring for life-threatening side effects of medications.

- **Best:** Portable monitor providing continuous vital signs display and capnography; document vital signs trends frequently.
- **Better:** Capnography (if controlled airway) in addition to minimum requirements.
- **Minimum:** Blood pressure cuff, stethoscope, pulse oximeter; document vital signs trends.

MEDICATIONS

NOTE: *Use the PFC Analgesia and Sedation Guideline table (Appendix A) for recommended treatments.*

- *Ketamine drip recommendations are detailed in Appendix B.*
- *A "cheat sheet" of common IV medications is listed in Appendix C.*
- *Providers using these guidelines should be intimately familiar with the medications in Appendix D, including their pharmacology, and side-effects.*

The PFC Analgesia and Sedation Guideline table in Appendix A is arranged according to anticipated clinical conditions, corresponding goals of care, and the capabilities needed to provide effective analgesia and sedation according to (1) the minimum standard, (2) a better option when mission and equipment support is available (all medics should be trained to this standard), and (3) the best option that may only be available in the event a medic has had additional training and experience, and/or equipment is available. The table is intended to be a quick reference guide but is not stand alone: you must also know the information in the rest of the guideline.

Medications in the table are presented as either Give or Consider.

- **Give:** Strongly recommended.
- **Consider**: Requires a complete assessment of patient condition, environment, risks, benefits, equipment, and provider training.

Step 1. *Identify the clinical condition.*

- **Standard analgesia** is for most patients. The therapies used here are the foundation for pain management during PFC. Expertise in dosing oral transmucosal fentanyl citrate (OTFC) and augmenting it with low dose ketamine IV or IO is a must.
- **Difficult analgesia or sedation needed** is for patients in whom standard analgesia does not achieve adequate pain control without suppressing respiratory drive or causing hypotension, OR when mission requirements necessitate sedating a patient to gain control over his/ her actions to achieve patient safety, quietness, or necessary positioning.
- **Protected airway with mechanical** ventilation is for patients who have a protected airway and are receiving mechanical ventilatory support or are receiving full respiratory support via assisted ventilation (i.e., bag valve).
- **Shock present** is for patients who have hypotension and shock.

Step 2. *Read down the column to the row representing your available resources and training.*

Step 3. *Provide analgesia/sedation medication accordingly.*

Step 4. *Consider using the Richmond Agitation-Sedation Scale (RASS) score (Appendix F) as a method to trend the patient's sedation level.*

For IV/IO drip medications:

- Use normal saline to mix medication drips when possible, but other crystalloids (e.g., lactated Ringer's, Plasmalyte, and so forth) may be used if normal saline is not available.
  - DO NOT mix more than one medication in the same bag of crystalloid because this practice has not been studied and may not be safe. Mixing medications together, even for a relatively short time, may

cause changes to the chemical structure of one or both medications and could lead to toxic compounds. There is ongoing research to determine the safety of such practices.

- If a continuous drip is selected, use only a ketamine drip in most situations, augmented by push doses of opioid and/or midazolam if needed. Multiple drips are difficult to manage and are generally not recommended. Multiple drips should only be undertaken with assistance from a telemedicine consultant with critical care experience. Multiple drips are most likely to be helpful in patients who remain difficult to sedate with ketamine drip alone and can "smooth out" the sedation (i.e., fewer peaks and troughs of sedation with corresponding deep sedation mixed with periods of acute agitation).

REGIONAL ANESTHESIA

(Appendix E)

Regional anesthesia (e.g., local anesthetic such as ropivacaine or lidocaine injected adjacent to a large, extremity nerve bundle or on either side of a finger or toe) is a useful technique that can markedly reduce or eliminate limb pain without risk of opioid or benzodiazepine side-effects of respiratory depression, sedation, and hypotension. There are, however, serious potential morbidities (and mortality from proximal injections or injection directly into blood vessels) that may occur.

For these reasons, this guideline has attempted to balance the overall risks and potential benefits of this intervention by recommending optimal procedure technique (e.g., use of ultrasound), a limited number of block sites, and the safest medication and dose combination. It should be noted that even with optimal technique, the risk of systemic toxicity (e.g., seizure or cardiac arrest) is not eliminated. Toxicity occurs either with direct injection of anesthetic into the systemic blood circulation or by absorption over the first 15–20 minutes after injection. Close monitoring MUST be available during this time.

Regional anesthesia should only be used by trained individuals. There should be documentation of competency. Three techniques exist:

1. **Ultrasound-guidance:** used to visualize targeted nerves, needle placement, and the spread of local anesthetic in real time.
2. **Nerve stimulation:** requires an assistant, a nerve stimulator, specialized needles, and cannot be reliably applied in cases of partial or complete amputations, given the inability to elicit motor response in severed muscles.
3. **Blind or anatomical technique:** should be reserved for distal nerve blocks only (i.e. fingers or toes).

ANALGESIA AND SEDATION FOR EXPECTANT CARE (I.E. END- OF –LIFE CARE)

An unfortunate reality of our profession, both military and medical, is that we encounter clinical scenarios that will inevitably end in a patient's death. In these situations, it is a healthcare provider's obligation to give palliative therapy to minimize the person's suffering. In these circumstances, the use of opioid analgesics and sedative medications is therapeutic and indicated, even if these medications worsen a patient's vital signs (i.e., cause respiratory depression and/or hypotension). If a patient is expectant:

Call a telemedicine consult.

- **Prepare** to

  - Give opioid (morphine is preferred, but hydromorphone, fentanyl, or other opioid can be given) until the patient's pain is relieved. If the patient is unable to communicate their pain, give opioid medication until the respiratory rate is less than 20/min.
  - If the patient complains of feeling anxious (i.e. is worrying about the future but not complaining of pain) or he cannot express himself but is agitated despite having a respiratory rate less than 20/min, give a benzodiazepine until the anxiety is relieved or the patient is sedated (i.e. is not feeling anxious or is no longer agitated).
- **Position** the patient as comfortably as possible. Pad pressure points.
- **Provide** anything that gives the patient comfort (e.g., water, food, cigarette).
- **Relief** of suffering, primarily through pain relief, is the goal during expectant care.

Call a telemedicine consult to discuss.

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APPENDIX A: PFC ANALGESIA AND SEDATION GUIDELINE

Step 1. Identify the clinical situation on the top row.
Step 2. Read down the column to the row representing your available resources and training.
Step 3. Provide analgesia/sedation medication accordingly.

	Standard Analgesia *(Most Patients)*	**Difficult Analgesia or Sedation Needed** *(e.g., Polytrauma/Litter Bound/Mission Demand)*	**Protected Airway** *(e.g., Intubated/Cricothyrotomy + Assisted Ventilation*	**Shock Present**
Goal	Minimize pain and anxiety and maintain normal physiology: • Airway – mental status adequate to protect airway (i.e., coughs, not snoring or obstructing airway) • Breathing – adequate ventilation (RR > 12/min, $EtCO_2$ < 50mmHg) and oxygenation (SpO_2 > 96%[1] • Perfusion – systolic blood pressure > 90mmHg	In addition to standard analgesia goals: • Control pain unresponsive to standard analgesia • Achieve quiet, calm casualty who can still be aroused	• Maintain airway device (deep sedation) • Achieve patient-ventilator synchrony • Maintain blood pressure	• Initiate treatment for shock before giving analgesia or sedation • Do not worsen shock
Minimum	• *Give*: acetaminophen 1,000mg PO every 6 hours • *Give*: meloxicam 15mg PO daily • *Give:* OTFC 800µg per TCCC guidelines • *Give*: ketamine push[1] • *Give*: ondansetron 4mg ODT/IV/IO/IM every 4 hours PRN	• *Give*: Standard analgesia *plus* • *Give*: hydromorphone or alternate opioid[2] • *Give*: ondansetron 4mg ODT/IV/IO/IM every 4 hours PRN	• *Give*: ketamine push[1] • *Give*: hydromorphone or alternate opioid[2] • *Give*: ondansetron 4mg ODT/IV/IO/IM every 4 hours PRN	• *Give*: ketamine push[1] • *Give*: ondansetron 4mg IV/IO every 4 hours PRN
Better	• *After initial pain control with OTFC and/or ketamine* • *Give*: acetaminophen/oxycodone (e.g., Percocet; if able to take PO)[2]	• *Give*: Standard analgesia *plus* • *Give*: hydromorphone or alternate opioid[2] • *Give*: midazolam[2]	• *Give*: ketamine push[1] • *Give*: hydromorphone or alternate opioid[2] • *Give*: midazolam[2] • *Give*: ondansetron 4mg ODT/IV/IO/IM every 4 hours PRN	• Same as minimum
Best	• *Give*: Regional nerve block for limb trauma (See Appendix E)	• Standard analgesia plus • *Give*: hydromorphone or alternate Opioid [2,5] • *Give*: midazolam[2] • Consider: ketamine load, then drip (for sedation)[3,4]	• *Give*: ketamine load, then drip (for sedation) [3,4] • *Give*: hydromorphone or alternate opioid [2,5] • *Give*: midazolam[2]	• *Give*: ketamine push[1] OR • Consider: ketamine load, then drip (for sedation)[3,4] If additional sedation needed AND blood pressure will tolerate: • Consider: hydromorphone or alternate opioid [2,5] • Consider: midazolam[2]

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$EtCO_2$, end-tidal carbon dioxide; IM, intramuscular; IO, intraosseous; IV, intravenous; OTFC, oral transmucosal fentanyl citrate; PO, per os (by mouth); PRN, as needed; RR, respiratory rate; SpO_2, oxygen saturation; TCCC, Tactical Combat Casualty Care.

Note: Lower doses of pain/sedation medications given more frequently are best for steady control. START LOW, GO SLOW.

[1]Ketamine push (for pain): 20mg (range, 0.1–0.2mg/kg) IV/IO every 10–30 minutes PRN. If an IV/IO is not available, quadruple the ketamine dose to give 80mg IM (range, 0.4–0.8mg/kg IM).

[2]To identify the effective dose of pain or sedation medication, give the lowest dose every 2–5 minutes until therapeutic target achieved or maximum dose is given. The effective dose is the amount required to achieve the desired effect (i.e., pain control or sedation). If unable to achieve target with maximum-dose opioid, add midazolam.

- Hydromorphone 0.5mg (range, 0.25–2mg) IV/IO every 1–6 hours PRN (long acting, effective, fewest side-effects)
- ALTERNATIVE opioid:
  - Fentanyl 50µg (range, 25–100µg) IV/IO every 30 minutes to 2 hours PRN (short acting, extremely fast onset, good for severe pain/procedures, greatest risk of respiratory depression)
  - Morphine 5mg (range, 2.5–10mg) IV/IO every 1–6 hours PRN (Long acting, more side-effects)
- Midazolam 1mg (range, 0.5–2 mg) IV/IO every 1–6 hours PRN (sedation, amnesia)
- Percocet 1–2 tab PO every 4 hours PRN (slower onset but provides steady pain control for up to 6 hours). Can supplement with effective dose of IV/IO opioids or ketamine for breakthrough pain. *Contains 650mg acetaminophen. Do not exceed 4,000mg acetaminophen per day.*

[3]***Ketamine loading dose (for sedation): 1mg/kg IV push over 60 seconds, then drip for continuous sedation. See mixture and dosing tables in Appendix B. Ketamine may be used for either pain control or sedation, depending on the dose.***

[4]A continuous ketamine drip may take an hour to take full effect or wear off. Always start with a loading dose and augment with an effective dose of opioid and/or midazolam if additional sedation is needed. Increase or decrease drip gradually.

[5]If breakthrough pain occurs on ketamine drip, give an effective dose of opioid. If effective dose is needed twice in 1 hour, increase drip rate to next higher level. If no breakthrough pain in past 2 hours, decrease drip rate to next lower level.

Note: Consider using the RASS score as a method to trend the patient's sedation level. See Appendix F.

Call telemedicine consult if you are having difficulty managing pain or sedation.

APPENDIX B: KETAMINE DRIP DOSING TABLES

Ketamine drip (for sedation): Sedation loading dose first (1mg/kg IV/IO over 60 seconds).
MIX: 750mg (1.5 vials of 500mg/5mL) in 250mL of normal saline (3mg/mL solution).

Initial drip dose:

- **Best:** Using an IV pump, set to µg/kg/min dose desired. Increase or decrease dose by 5–10µg/kg/min increments.
- **Better:** Using a dial flow adaptor, initial drip rate in mL/h equals the casualty's weight in kg divided by 2 (see mL/h table).
- **Minimum:** Count drip rate. Increase or decrease rate by 1–2 drips/min (very slowly) to achieve goal.

Drip adjustments: Increase or decrease drip by 0.25mg/kg/h (1 row).

Ketamine Drip Dosing Tables

Ketamine drip rate for dial flow or IV pump (starting dose highlighted)

Dose		Patient's Weight, kg			
		40	60	80	100
mg/kg/h	µg/kg/min	Infusion Rate, mL/h			
0.5	8	7*	10	13	17
0.75	13	10	15	20	25
1.0	17	13	20	27	33
1.25	21	17	25	34	42
1.5	25	20	30	40	50
1.75	29	24	35	47	59
2.0	33	27	40	53	67

Ketamine drip count for 15 drips/mL tubing (starting dose highlighted)

		Infusion Rate, 1 drip/X seconds			
0.5	8	1/35	1/24	1/18	1/9
0.75	13	1/27	1/18	1/14	1/8
1.0	17	1/18	1/12	1/9	1/7
1.25	21	1/15	1/10	1/8	1/6
1.5	25	1/12	1/8	1/6	1/5
1.75	29	1/11	1/7	1/6	1/5
2.0	33	1/9	1/6	1/5	1/4

Ketamine drip count for 10 drips/mL tubing (starting dose highlighted)

		Infusion Rate, 1 drip/X seconds			
0.5	8	1/53	1/36	1/27	1/14
0.75	13	1/41	1/27	1/21	1/12
1.0	17	1/27	1/18	1/14	1/11
1.25	21	1/23	1/15	1/12	1/9
1.5	25	1/18	1/12	1/9	1/8
1.75	29	1/17	1/11	1/9	1/8
2.0	33	1/14	1/9	1/8	1/6

Procedural Sedation

Step 1: Bolus (1.0–2.0mg/kg) 80–160mg ketamine IV/IO over 60 seconds (250–400mg IM if necessary).
Step 2: Consider adding (start low, give more):
- 25–100µg fentanyl IV/IO
- 1–4mg midazolam IV/IO

Step 3: May need to repeat doses as below if procedure lasts longer than 10–15 minutes.
- Ketamine every 10–15 minutes
- Fentanyl every 15–30 minutes
- Midazolam every 30–60 minutes

*dial flow adaptor not accurate for rate < 10mL/h; use drip count

APPENDIX C: COMMON IV MEDS CHEAT SHEET

Common IV Meds Cheat Sheet			
	Moderate Pain	**Pain Dose Range**	**Sedation**
Ketamine	20mg IV	0.1–0.2mg/kg IV	1mg/kg IV
Midazolam	1mg IV	0.5–2mg IV	1mg every 1–6 hours
Morphine	5mg IV	2.5–10mg IV	
Fentanyl IV	25µg IV	25–100µg IV	
Hydromorphone	0.5–1mg IV	0.25–2mg IV	
OTFC	800µg pop: between cheek and gum		
Opioid overdose	Naloxone: Dilute 0.4mg (1mL) with 9mL normal saline. Give 1ml slowly. Repeat dose PRN		
Benzodiazepine overdose	Flumazenil: ▪ Draw 1mL (0.5mg) ▪ Dilute with 4mL sterile water (0.1mg/mL) ▪ Give 3mL/0.3mg over 15 seconds ▪ Additional 1mL/0.1mg every 1 minute PRN Maximum dose, 1mg/h (can cause seizures)		
The moderate-pain category follows this clinical practice guideline philosophy: Prolonged field care analgesia/sedation should begin with smaller amounts of a drug first: START LOW, GO SLOW. The doses are not all inclusive; therefore, the dose by weight or a safe range is also included.			

IV, intravenous; OTFC, oral transmucosal fentanyl citrate; PRN, as needed.

APPENDIX D: RECOMMENDED PAIN AND SEDATION MEDICATION

Recommended Pain and Sedation Medication			
Name	**Purpose/Dose**	**Side Effects and Notes**	**Pharmacology**
Ketamine (Ketalar)	**Background pain:** • Use low dose 10–20mg (0.1–0.2mg/kg) OV/IO PRN. • Avoid oversedation **Breakthrough pain** in hemodynamically stable or unstable patient: IV/IO push: dose every 5 minutes until goal achieved or nystagmus occurs or RR < 10/min. • 10–20mg (or 0.1–0.2mg/kg) slow push **IM/IN**: every 15 minutes until goal achieved or nystagmus occurs • 40–60mg (or 0.5–0.75mg/kg) **Sedation**: IM sedation dose: • 250–400mg (or 4–5mg/kg) **IV/IO sedation** loading dose: • 1mg/kg IV push over 60 seconds Then **IV/IO drip** for ongoing sedation (load above dose, then drip): • Nonintubated: 1mg/kg/h • Intubated 1–2mg/kg/h	• Cataleptic-like state (dissociated from the surrounding environment) • Respiratory depression at higher doses (>1mg/kg), especially with fast administration IV/IO • Sialorrhea (hypersalivation) (can be problematic in an austere setting). • Releases endogenous catecholamines (epinephrine, norepinephrine), which maintain (or increase) blood pressure and heart rate. • *Consider adding midazolam to avoid emergence phenomenon (e.g., delusions, agitation, irrational/violent behavior) in adults with higher doses (>0.3mg/kg IV/IO)* • *Consider glycopyrrolate if significant sialorrhea* • *Consider antiemetic (e.g., odansatron) empirically (may vomit when recovering from sedation)* • *To avoid rapid respiratory depression, IV/IO administration should be slow: Push no faster than over 60 seconds* • No additional sedation or analgesic effects with doses >1.5mg/kg—only longer duration of effects. • There are no absolute contraindications for the use of ketamine; ketamine is safe for use in TBI and/or eye injury.	• NMDA antagonist • Time to onset: 30 seconds IV or 1–5 minutes IM • Duration of action: 10–15 minutes IV or 20–30 • minutes IM • S(+) ketamine has four times the affinity of R(−) ketamine for the NMDA receptor (S ketamine is common in non-US pharmacies) • In practice, S(+) ketamine (e.g., Esketamin, Ketanest) is twice as potent; use half the recommended dose in mg as racemic (“regular”) ketamine • Mid-range dose (0.3–0.8mg/kg IV/IO) has the highest incidence of emergence reactions and dysphoria. AVOID THIS DOSE WHENEVER POSSIBLE. Treat with midazolam or other benzodiazepine (or rebolus ketamine with sedation dose) • Metabolized in the liver to an active metabolite, norketamine, which has a potency one-third that of ketamine • Renal excretion
Hydromorphone (Dilaudid)*	Breakthrough pain in hemodynamically stable patient: IV/IO/ IN: dose every 5 minutes until goal achieved or RR < 10/min. • Nonintubated: 0.25–2mg • Intubated: 1–4mg IM: not recommended	• Respiratory/cardiac/mental status depression • Nausea/vomiting • Pruritus (itching) • Constipation	• Onset <5 minutes • Duration of action 1–4 hours • Hepatic metabolism • Renal clearance (~10% as unchanged drug) • Caution in hepatic/renal impairment (reduce dose by 25%) • IM dose variable and delayed

Recommended Pain and Sedation Medication			
Name	**Purpose/Dose**	**Side Effects and Notes**	**Pharmacology**

Fentanyl* (Actiq)**	**Background pain:**
	Oral: only in NONINTUBATED, awake patients, per TCCC guidelines
	• OTFC 800µg
	  • Place lozenge between the cheek and the gum
	  • Do not chew the lozenge
	Breakthrough pain in hemodynamically stable patient:
	IV/IO/ IN: dose every 5 minutes until goal achieved or RR < 10/min.
	• Nonintubated: 25–50µg
	• Intubated: 50–200µg
	**IV push should be over 30–60 seconds, monitor for difficulty breathing (e.g., rigid chest syndrome)
	IM: not recommended
		• Respiratory/cardiac/mental status depression
		• Nausea/vomiting
		• Pruritus (itching)
		• Constipation
		
		Unique concerns:
		• Chest-wall muscle rigidity with rapid IV infusion (rare)
		• Bradycardia (rare)
		• QT-interval prolongation (rare)
		• Highly lipophilic
			• Rapid IV onset (<2 minutes)
			• Duration of action: 30–60 minutes
			• Hepatic metabolism
			• Renal clearance (~10% as unchanged drug)
			• Caution in hepatic/renal impairment (reduce dose by 25%)

Morphine**	**Breakthrough pain** in hemodynamically stable patient: IV/IO/ IN: dose every 5 minutes until goal achieved or RR < 10/min. • Nonintubated: 2.5–10mg • Intubated: 5–10mg IM: not preferred; can give 5–10mg IM if necessary	• Respiratory/cardiac/mental status depression • Nausea/vomiting • Pruritus (itching) • Constipation • Anticholinergic like effects, particularly urinary retention	• Onset <5 minutes. • Active metabolites. • **Duration of action: 1–4 hours** • 85% renal clearance; 7%–10% bile/stool clearance • Significantly reduced clearance in renal failure • IM dose variable and delayed
Percocet	**Background pain** Contains oxycodone (5mg) AND acetaminophen (325mg) **PO/enteral (may be crushed):** 1–2 tabs every 4–6 hours. • DO NOT exceed 4,000mg total acetaminophen per day.	• Respiratory/cardiac/mental status depression • Nausea/vomiting • Pruritus (itching) • Constipation • Hypersensitivity (rare) • Liver toxicity (acetaminophen) at high doses or if compromised liver function at baseline	• Oxycodone • Hepatic metabolism • Active metabolites • Urinary excretion • **Duration of effect: 4–6 hours** Acetaminophen (see below)
Midazolam (Versed)	**Sedation** (includes anxiety or agitation): **IV/IO**: dose every 5 minutes until goal achieved or RR < 10/min. • Nonintubated: 0.5–2mg • Intubated: 1–4mg **IM**: not recommended	• Respiratory/cardiac/mental status depression • Amnestic • Nausea/vomiting • Hypotension • Constipation • Personnel and equipment needed for standard respiratory resuscitation should be available during midazolam administration.	• Onset: 1–5 minutes • **Duration of effect: 1–4 hours** • Hepatic metabolism (active metabolites) • Renal excretion
Glycopyrrolate (Robinul)	Antisialogogue (i.e., to stop hypersalivation from ketamine) **SC/IM/IV/IO**: • 0.1–0.2mg every 4 hours	• Tachycardia/palpitations • Nausea/vomiting • Flushing • Urinary retention • Not to exceed 4 doses/d	• Anticholinergic • Rapid onset • Duration of effect: 2–6 hours • Renal excretion (85%, 80% unchanged)

Recommended Pain and Sedation Medication			
Name	**Purpose/Dose**	**Side Effects and Notes**	**Pharmacology**
Acetaminophen (Tylenol)	For mild to moderate pain: **IV/PO**: 500–1000mg every 6 hours	• Hypersensitivity (rare) • Increased serum transaminases • Nausea/vomiting (IV) • **Acute liver failure: limit daily dose of acetaminophen and acetaminophen-containing products (e.g., Percocet) to 4,000mg**	• Onset: <1 hour PO, 5–10 minutes IV • Duration of effect: 4–6 hours • Hepatic metabolism • Renal excretion
Odansatron (Zofran)	For nausea and vomiting: • 4mg ODT/IV/IO/IM, every 4–8 hours PRN • Can repeat once at 15 minutes if nausea and vomiting are not improved	• Maximum 8mg in any 8-hour interval • QT-interval prolongation (rare) • Constipation • Dizziness/headache	• Selective serotonin 5-HT3 receptor antagonist • Hepatic metabolism • Excreted in the urine and feces
Flumazenil (Romazicon)	For reversal of benzodiazepine overdose (e.g., midazolam) • 0.2mg IV over 15 seconds	• DO NOT USE IN CHRONIC BENZODIAZEPINE USERS! (May cause seizures) • Use only to reverse benzodiazepines YOU have given the patient.	• Specific benzodiazepine receptor antagonist • **Resedation may occur 20–60 minutes after initial dose, may require redosing** • Hepatic metabolism • Renal excretion
Naloxone (Narcan)	For reversal of opioid overdose • 0.4–2mg IV/IM/SC/IN; repeat every 2–3 minutes PRN; not to exceed 10mg (0.01mg/kg)	• Withdrawal reaction precipitated • Abrupt reversal of opioid depression may result in nausea, vomiting, sweating, tachycardia, increased blood pressure, and tremulousness • **Short duration of action relative to longer-acting opioids (e.g., morphine); may need to redose before opioid effect has worn off**	• Competitive opioid antagonist • Onset: 2 minutes IV; 2–5 minutes IM/SC • **Duration of effect: 30–60 minutes, may require redosing** • Hepatic metabolism • Renal excretion
Diphenhydramine (Benadryl)	For itching or allergic reaction (may also cause drowsiness) • 25–50mg IV/IO/PO every 4–6 hours PRN (maximum: 400mg daily)	• May potentiate the effect of other sedative agents • May reduce seizure threshold • May cause paradoxical CNS stimulation (e.g., agitation or anxiety) and/or psychosis • Mild anticholinergic and may cause dry secretions (dry mouth, constipation, urinary retention), blurred vision, flushing, fever, tachycardia • May reduce nausea	• Histamine receptor (H1) antagonist • Hepatic metabolism • Renal excretion

CNS, central nervous system; IM, intramuscular; IN, intranasal; IO, interosseous; IV, intravenous; NMDA, N-methyl-d-aspartate; ODT, oral disintegrating tablet; OTFC, oral transmucosal fentanyl citrate; PO, *per os* (by mouth); PRN, as needed; RR, respiratory rate; SC, subcutaneous; TBI, traumatic brain injury; TCCC, Tactical Combat Casualty Care.

***Hydromorphone is selected as the opioid medication of choice in the PFC setting for the following reasons:**

1. Long acting
2. Lower likelihood of accumulating in the setting of organ dysfunction (particularly renal injury/insufficiency) and, therefore, less likely to cause respiratory depression or hypotension
3. Smaller doses produce greater effect; thus, less medication needs to be carried for longer duration of treatment
4. Less histamine activation, less pruritus, better tolerated

****Morphine**

1. Long acting
2. Can give IM if necessary, but not preferred
3. More side-effects compared with hydromorphone (e.g., higher rate of respiratory depression, hypotension, and pruritus)

*****Fentanyl**

1. Short acting
2. Faster onset
3. Greatest risk of respiratory depression; highly recommend monitoring SpO2 (oxygen saturation)
4. Be prepared to support breathing if necessary
5. Reserved for severe pain or procedures

APPENDIX E: REGIONAL ANESTHESIA – RECOMMENDATIONS

REGIONAL ANESTHESIA - RECOMMENDATIONS

WORKING DEFINITION

It is a useful technique of local anesthetic agent injection adjacent to a single nerve or a nerve bundle, that can markedly reduce or eliminate limb-related pain without negative systemic effects such as respiratory depression, sedation or hypotension.

BEFORE ATTEMPTING - COMPETENCY IN ANY BLOCK PERFORMED MUST BE DOCUMENTED
ULTRASOUND GUIDANCE IS THE PREFERRED MODALITY FOR BLOCKS

BENEFITS

- Superior pain control in patients with limb injuries.
- Successful block decreases your patient's need for systemic analgesia. May need less or none at all.
- It is logistically easier to take care of a patients who doesn't need heavy sedation or systemic analgesia.

RISK

- LAST (local anesthetic systemic toxicity) - serious cardiovascular & CNS toxicity from accidental injection into the blood vessels or from absorption into systemic circulation - know signs & symptoms; stay out of blood vessels when injecting local anesthetics!
- Accidental nerve damage from needle or injection into the nerve - don't inject against resistance!
- Increased risk of unrecognized compartment syndrome or local pressure wounds given patient cannot provide feedback due to lack of sensory (+/- motor) function in a blocked extremity.
- Risk from injury to surrounding structures such as blood vessel injury or a pneumothorax.

SYMPTOMS & SIGNS OF LAST:

- NERVOUS SYSTEM:
  - perioral numbness, tingling, metallic taste, tinnitus, muscle twitching, visual disturbance, extreme anxiety, screaming, impending death feeling, SEIZURE, COMA
- CARDIOVASCULAR SYSTEM:
  - chest pain, shortness of breath, diaphoresis, ARRHYTHMIA, HYPOTENSION, CARDIOVASCULAR COLLAPSE

RECOMMENDED MODALITIES:

- ☐ **Ultrasound-guidance** for real-time visualization of targeted nerves, needle & anesthetic spread. It is recommended for any block performed (except digital blocks).
- ☐ **Paresthesia/anatomical technique** may be used for distal nerve blocks if no ultrasound available.

HOW TO MINIMIZE RISK:

- ☐ Know the drugs you have available and ensure you have easy access to procedural references prior to deployment.
- ☐ Establish **baseline neurological function** of a given extremity prior to block.
- ☐ **Calculate the maximum total dose** of local anesthetic for your patient and never exceed it when performing multiple blocks.
- ☐ Use **local anesthetics with epinephrine for all blocks** to facilitate immediate recognition of intravascular injection.
- ☐ Use **blunt-tip needles** to minimize nerve injury.
- ☐ **Monitor your patient** during the injection & for 15-20 minutes after the procedure.
- ☐ Use **pulse oximetry with audible signal** as the **minimum** monitoring device when performing regional nerve blocks.
- ☐ **Mark & date all the block sites** with a permanent marker on the skin.
- ☐ **Pad** all the pressure points
- ☐ Know how to manage **LAST** syndrome (see checklist).

RECOMMENDED LOCAL ANESTHETIC

ROPIVACAINE (0.2 % - 2mg/mL or 0.5% - 5mg/mL) is the local anesthetic of choice due to its excellent efficacy and improved cardiovascular safety profile.

MAXIMUM CUMULATIVE DOSE: 3 mg/kg (all blocks at multiple sites combined)

- ☐ 0.2% solution: 1.5mL/kg
- ☐ 0.5% solution: 0.6mL/kg

ONSET & DURATION: approximately 20 minutes from injection to onset of block. An effective dose provides 4-8 hours of anesthesia. The analgesic effect lasts for 5-12 hours.

Regional Anesthesia – Recommendations (Continued)

REGIONAL ANESTHESIA - WORKSHEET

PATIENT'S WEIGHT [kg]:	MAXIMUM CUMULATIVE DOSE:

RECOMMENDED UPPER EXTREMITY BLOCKS:

SEE REGIONAL ANESTHESIA REFERENCE - ULTRASOUND-GUIDED NERVE BLOCKS

- ☐ **SUPRACLAVICULAR BRACHIAL PLEXUS BLOCK** (must be performed under ultrasound guidance; inject 20-25mL of local anesthetic)
- ☐ **AXILLARY BRACHIAL PLEXUS BLOCK** (preferably under ultrasound guidance; inject 15-20mL of local anesthetic)
- ☐ **WRIST BLOCK: radial, median & ulnar nerves** (ultrasound use is optional; inject a total of 10mL of local anesthetic for all 3 nerves)
- ☐ **DIGITAL BLOCK** (inject < 5mL of local anesthetic)

RECOMMENDED LOWER EXTREMITY BLOCKS:

SEE REGIONAL ANESTHESIA (3) ULTRASOUND-GUIDED NERVE BLOCKS REFERENCE

- ☐ **FEMORAL NERVE BLOCK** (use ultrasound guidance; inject 10-20mL of local anesthetic)
- ☐ **PROXIMAL SCIATIC NERVE BLOCK** (subgluteal approach; use ultrasound guidance; inject 15-20mL of local anesthetic)
- ☐ **DISTAL SCIATIC NERVE BLOCK** (popliteal approach; use ultrasound guidance; inject 20mL of local anesthetic)
- ☐ **SAPHENOUS BLOCK** (ultrasound use is optional: proximal approach at tibial tuberosity; inject 10mL of local anesthetic)
- ☐ **ANKLE BLOCK: saphenous, sural, posterior tibial, superficial & deep peroneal nerves;** ultrasound use is optional; inject a total of 20mL of local anesthetic for all 5 nerves)
- ☐ **DIGITAL BLOCK** (inject < 5mL of local anesthetic)

CONTRAINDICATIONS:

- UNTRAINED PROVIDER
- Refusal & **inability to communicate with patient**
- Infants, children, elderly
- Infection at the injection site
- Trauma or history of trauma at the injection site
- Systemic anticoagulation/coagulopathy
- Pre-existing neurological disease

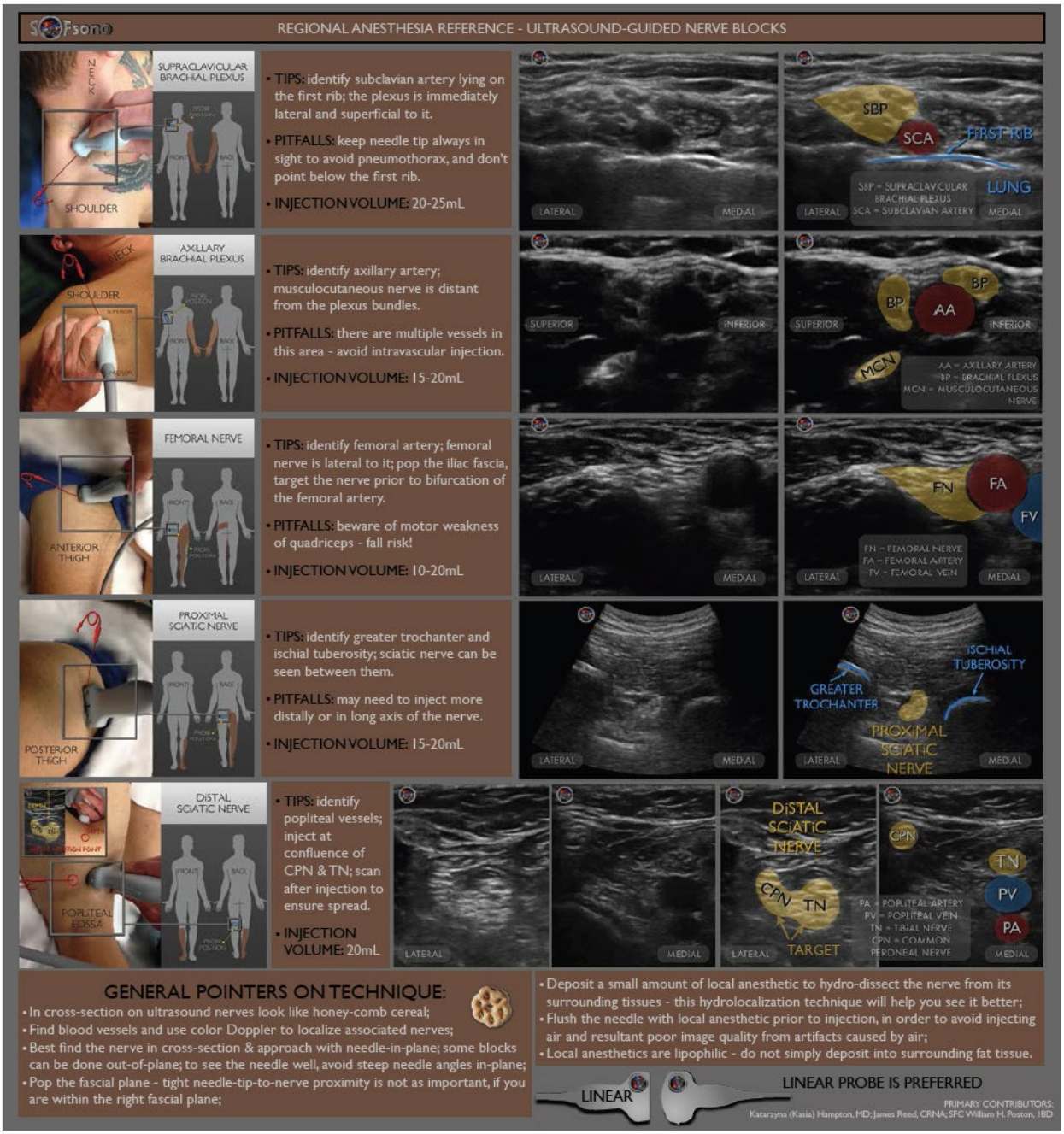
TECHNIQUE:

- Identify target nerve according to training
- Gather equipment and place the patient on monitor:
  - ☐ MINIMUM: pulse oximetry with audible signal
  - ☐ BETTER: add blood pressure monitoring
  - ☐ BEST: full monitor with EKG leads
- Prepare & label the syringes with local ANESTHETIC
- Clean (preferably sterile) procedure: cleanse injection site with chlorhexidine (preferred), betadine or alcohol, & use gloves (best sterile)
- Ensure good verbal and visual communication with the patient prior to injection
- Introduce needle and aspirate for blood; then inject 1 mL of anesthetic, and if no resistance, then aspirate again & slowly inject 3-5mL, and wait 60 seconds to monitor for toxicity. **STOP IF if any signs or symptoms of toxicity or other adverse events occur**
- Continue injection if no changes occur
- **Always aspirate before any injection**
- Slowly inject your target dose for a given block in **5-mL increments** given over 10-15 sec each, and **always aspirate for blood** between each 5-mL increment
- Mark and date each block site

Local Anesthetic Systemic Toxicity (LAST) checklist:

- STOP injection at first sign or symptom!
- Airway management: use 100% oxygen
- Seizure management: benzodiazepines are preferred; can give propofol (25-50mg) if hemodynamically stable
- Use ACLS protocols for cardiovascular collapse
- **20% LIPID EMULSION** is the antidote:
  - ☐ 1 mL/kg every 3-5 minutes IV, up to 3mL/kg IV during ACLS
  - ☐ Follow with continuous infusion 0.25mL/kg/min
  - ☐ Double the infusion rate to 0.5mL/kg/min if blood pressure remains low
  - ☐ Continue infusion for at least 10 minutes once hemodynamically stable
  - ☐ Upper limit: approx. 10mL/kg IV over 30 minutes

Regional Anesthesia – Recommendations (Continued)


REGIONAL ANESTHESIA REFERENCE - ULTRASOUND-GUIDED NERVE BLOCKS
SUPRACLAVICULAR BRACHIAL PLEXUS
SHOULDER
• TIPS: identify subclavian artery lying on the first rib; the plexus is immediately lateral and superficial to it.
• PITFALLS: keep needle tip always in sight to avoid pneumothorax, and don't point below the first rib.
• INJECTION VOLUME: 20-25mL
LATERAL
MEDIAL
SBP
SCA
FIRST RIB
LUNG
SBP = SUPRACLAVICULAR BRACHIAL PLEXUS
SCA = SUBCLAVIAN ARTERY
AXILLARY BRACHIAL PLEXUS
NECK
SHOULDER
• TIPS: identify axillary artery; musculocutaneous nerve is distant from the plexus bundles.
• PITFALLS: there are multiple vessels in this area - avoid intravascular injection.
• INJECTION VOLUME: 15-20mL
SUPERIOR
INFERIOR
BP
AA
MCN
AA = AXILLARY ARTERY
BP = BRACHIAL PLEXUS
MCN = MUSCULOCUTANEOUS NERVE
FEMORAL NERVE
ANTERIOR THIGH
• TIPS: identify femoral artery; femoral nerve is lateral to it; pop the iliac fascia, target the nerve prior to bifurcation of the femoral artery.
• PITFALLS: beware of motor weakness of quadriceps - fall risk!
• INJECTION VOLUME: 10-20mL
FN
FA
FV
FN = FEMORAL NERVE
FA = FEMORAL ARTERY
FV = FEMORAL VEIN
PROXIMAL SCIATIC NERVE
POSTERIOR THIGH
• TIPS: identify greater trochanter and ischial tuberosity; sciatic nerve can be seen between them.
• PITFALLS: may need to inject more distally or in long axis of the nerve.
• INJECTION VOLUME: 15-20mL
ISCHIAL TUBEROSITY
GREATER TROCHANTER
PROXIMAL SCIATIC NERVE
DISTAL SCIATIC NERVE
POPLITEAL FOSSA
• TIPS: identify popliteal vessels; inject at confluence of CPN & TN; scan after injection to ensure spread.
• INJECTION VOLUME: 20mL
DISTAL SCIATIC NERVE
CPN
TN
TARGET
PV
PA
PA = POPLITEAL ARTERY
PV = POPLITEAL VEIN
TN = TIBIAL NERVE
CPN = COMMON PERONEAL NERVE
GENERAL POINTERS ON TECHNIQUE:
• In cross-section on ultrasound nerves look like honey-comb cereal;
• Find blood vessels and use color Doppler to localize associated nerves;
• Best find the nerve in cross-section & approach with needle-in-plane; some blocks can be done out-of-plane; to see the needle well, avoid steep needle angles in-plane;
• Pop the fascial plane - tight needle-tip-to-nerve proximity is not as important, if you are within the right fascial plane;
• Deposit a small amount of local anesthetic to hydro-dissect the nerve from its surrounding tissues - this hydrolocalization technique will help you see it better;
• Flush the needle with local anesthetic prior to injection, in order to avoid injecting air and resultant poor image quality from artifacts caused by air;
• Local anesthetics are lipophilic - do not simply deposit into surrounding fat tissue.
LINEAR
LINEAR PROBE IS PREFERRED
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APPENDIX F: THE RICHMOND AGITATION-SEDATION SCALE (RASS)[12]

+4	Combative	Combative, violent, immediate danger to staff
+3	Very agitated	Pulls to remove tubes or catheters; aggressive
+2	Agitated	Frequent non purposeful movement; fights ventilator
+1	Restless	Anxious, apprehensive, movements not aggressive
0	Alert and calm	Spontaneously pays attention to caregiver
-1	Drowsy	Not fully alert but has sustained awakening to voice (eye opening and contact >10 seconds)
-2	Light sedation	Briefly awakens to voice (eyes open and contact <10 seconds)
-3	Moderate sedation	Movement of eye opening to voice (no eye contact)
-4	Deep sedation	No response to voice but movement or eye opening to physical stimulation
-5	Unarousable	No response to voice or physical stimulation

Procedure for RASS assessment	Score
1. Observe patient. • Patient is alert, restless, or agitated.	0 to +4
2. If not alert, state patient's name and tell patient to open eyes and look at speaker. • Patient awakens with sustained eye opening and eye contact. • Patient awakens with eye opening and eye contact, but not sustained. • Patient has any movement in response to voice but no eye contact.	 −1 −2 –3
3. When no response to verbal stimulation, physically stimulate patient by shaking shoulder and/or rubbing sternum. • Patient has any movement to physical stimulation. • Patient has no response to any stimulation.	 −4 −5

APPENDIX G: PLANNING CONSIDERATIONS

Best:	Better:	Minimum:
• Fluids: fluid for medication administration/drip (normal saline [NS]: 100mL/250mL bags and 5mL/10mL prefilled syringes) • Equipment: portable monitor with capnography, laboratory capability for serum electrolytes, arterial blood gases, lactate, Foley catheter with graduated collection system, portable ventilator, portable suction, portable sonography, airway management kit to include endotracheal suction catheter • Macro/microdrip intravenous (IV) administration tubing; • infusion pump • Analgesic medications: Ketamine, hydromorphone, fentanyl, morphine (for IV use), oral transmucosal fentanyl citrate (OTFC), Percocet tabs for oral (PO) use • Mild pain: meloxicam, acetaminophen • Sedation/Anxiety: midazolam for IV use (diazepam tabs for PO) • Mild pain: meloxicam, acetaminophen • Antisialogogue: glycopyrrolate • Antiemetic: ondansatron • Antihistamine and reversals: diyphenhydramine, flumazenil, naloxone • Local/regional anesthesia: 2% lidocaine/ropivacaine • Monitoring: portable monitor providing continuous vital sign display; capnography if intubated; document vital signs trends, intake and output, GCS, and pain level every 5 minutes until goal achieved, every 15 minutes thereafter; pain assessment sheet • Communications: real-time video telemedicine consultation • Push-pack capability: prepackaged additional 24-hour supplies of fluids, and medications for scenarios >24 hours.	• Fluid for medication administration/ drip (NS: 250mL bags and 10mL prefilled syringes) • Equipment: blood pressure cuff, stethoscope, pulse oximeter, capnometer, portable ventilator, Stimuplex (peripheral nerve stimulation), airway management kit to include endotracheal suction catheter, Micro/macrodrip tubing with dial-a-flow adaptor • Graduated container to monitor urine output • Analgesic medications: ketamine, hydromorphone for IV • Percocet tabs for PO • Mild pain: meloxicam, acetaminophen • Sedation/Anxiety: midazolam • Antiemetic: ondansatron • Antihistamine and reversals: diyphenhydramine, flumazenil, naloxone • Nonsteroidal anti-inflammatory drug (NSAID): acetminophen • Local/regional anesthesia: 2% lidocaine/ropivacaine • Monitoring: frequent vital signs, examination, fluid input/urine output • Communications: telephone; e-mail digital photos	• Fluids: NS: 250mL bags • Equipment: blood pressure cuff, stethoscope, pulse oximeter, bag-valve mask with positive end-expiratory pressure valve, airway management kit • Macrodrip tubing and counting drops per second to get infusion rate • Analgesic medications: ketamine, hydromorphone for IV, Percocet tabs for PO • Mild pain: meloxicam, acetaminophen • Sedation/Anxiety: midazolam • Antiemetic: ondansatron • Antihistamine and reversals: diyphenhydramine, flumazenil, naloxone • Local/regional anesthesia: 2% lidocaine/ropivacaine • Monitoring: frequent vital signs, examination, fluid input documented on preprinted or improvised flowsheet. • Communications: telephone

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APPENDIX H: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Anesthesia for Trauma Patients

Guidelines incorporate the induction and maintenance of anesthesia into an ongoing resuscitation during surgery for a trauma patient in extremis.

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SUMMARY OF CHANGES

01 Sep 2023 update: DEVICE data regarding video laryngoscope.

June 2023 update

- Calcium administration changed to 1 gram calcium
- Tranexamic acid (TXA) 2gm bolus is now favored over the traditional 1gm prehospital bolus followed by 1gm infusion over 8 hours. The 2gm TXA bolus should be given as close to the time of injury as possible and not outside of the 3 hours window.

05 Apr 2021 updates

1. Use Whole Blood (WB) if available. FDA-approved cold stored WB is preferred over fresh WB (non-FDA approved).
2. Initiate infusion of 2gmTranexamic Acid (TXA) IV/IO ASAP or within 3 hours of injury.
3. Carefully follow calcium concentration during massive transfusion. Consider giving empiric calcium if hypotensive.
4. Stronger evidence exists for use of vasopressin in hemorrhagic shock. Consider vasopressin bolus of 2-4 units followed by a vasopressin infusion (0.04 U/min) in cases of refractory shock.

BACKGROUND

Resuscitation goals for trauma patients have undergone significant change in the past decade. Appropriate blood product transfusion ratios, use of pharmacologic adjuncts (e.g., TXA) and other modalities have improved survival for the wounded combatant. In the operating room (OR), resuscitation occurs in the context of providing an anesthetic which minimizes hemodynamic instability in the severely injured patient. It is imperative, therefore, that the management of this resuscitation occurs simultaneously with surgery and anesthesia. While recent review articles, checklists and textbooks have drawn attention to the role of anesthetic resuscitation concurrent with surgical correction of injury, there is no guideline for the induction, maintenance, and transfer of anesthetic care of the military trauma patient in extremis.[1-4]

SPECIFIC CONSIDERATIONS FOR TRAUMA ANESTHESIA

PRE-INDUCTION

- Hypothermia is one of the arms of the lethal triad of coagulopathy, acidosis, and hypothermia.[5] As such, it is important to warm the OR to greater than 30C and have a warmed intravenous (IV) line, forced air warmer, and rapid infuser with warming capability immediately available. Standard checks (e.g., anesthesia machine check, airway equipment is in proper working order) assure that vital equipment is ready for immediate use.
- Establishment of a massive transfusion protocol and effective communication with the blood bank is essential and can improve survival.[6] The *Damage Control Resuscitation CPG*[7] defines the massive transfusion protocol for the combat theater. At all roles of care, awareness of the individual military medical facilities (MTFs) on-hand resources (including walking blood bank) and applicable protocols are key considerations.
- The presence of anesthesia in the trauma bay is necessary for smooth transition of care to the OR and offers the opportunity to assist with invasive procedures. Identification of team roles prior to patient arrival facilitates effective transfer from the delivering team.

INDUCTION OF ANESTHESIA

1. Induction of anesthesia in the exsanguinating patient can be challenging. **Ongoing volume resuscitation to prevent occurrence of cardiac arrest** in the peri-anesthetic period is critical.

2. After a patient is identified for surgery, **verification of functioning vascular access** (either intravenous or intraosseous) and placement of monitoring devices (e.g., oxygen saturation, blood pressure, and electrocardiogram) must occur quickly.

3. **Do not delay induction of the patient in extremis in order to place the central venous access or invasive monitoring.** Placing monitors at the same time as the surgical prep and drape can save time in a crisis. A wide draping procedure with “arms out” ensures adequate surgical exposure, while affording access to the arms as needed after the start of surgery. Pre-oxygenation with four full vital capacity breaths can “de-nitrogenate” the end alveoli sufficiently to optimize oxygenation prior to rapid sequence induction. In the obtunded patient, it may not be possible to achieve four vital capacity breaths prior to induction, and one must proceed with induction relying upon apneic oxygenation.

4. There are a variety of **sedative hypnotics** available for induction of anesthesia. Standard induction dosages should be reduced and titrated to balance the induction of anesthesia with hemodynamic changes. Ketamine (1 mg/kg) will not decrease the systemic vascular resistance to the same extent as other sedative hypnotics. While Propofol is a standard induction agent, it can decrease the systemic vascular resistance

significantly. It is prudent to use reduced doses of Propofol (0.5-1 mg/kg) in hypotensive patients. Ongoing volume resuscitation is vital to prevent vascular collapse.

5. **Neuromuscular relaxation** sufficient to facilitate endotracheal intubation can be achieved in approximately 45 seconds with succinylcholine in a standard rapid sequence induction dose (1mg/kg). Rocuronium is a non-depolarizing neuromuscular relaxant useful in cases where succinylcholine may be contraindicated (e.g., burns, spinal cord injury, hyperkalemia). An increased dose of Rocuronium (1-1.2 mg/kg) can produce intubating conditions similar to succinylcholine in approximately 60 seconds.

6. **Prompt endotracheal intubation of the trachea following induction** mitigates the risk of aspiration. Rapid sequence induction (RSI) with direct laryngoscopy is a safe and effective method to secure the airway of the trauma patient.[8, 9] The efficacy of in-line stabilization during RSI is somewhat controversial; however, it remains prudent to minimize the manipulation of the cervical spine to the extent possible during laryngoscopy. Regardless, it is re-assuring to know that spinal cord injury following direct laryngoscopy rarely causes or worsens cervical spine injury.[10]

7. A variety of **airway adjuncts** are available to the laryngoscopist. The gum elastic bougie can be helpful in securing a challenging airway and is a low-cost, effective airway adjunct.[11] Video laryngoscopy can provide an improved view of the vocal cords during intubation and has recently been shown to improve first pass success rate, especially for less experienced providers. Therefore, video laryngoscopes are preferred over direct laryngoscopes when available.[12] It remains prudent to have a limited number of immediately available airway adjuncts with which one is familiar, rather than a larger selection of less familiar equipment.[13] An alternate plan, including equipment for surgical airway management, must also be immediately available. (See *Airway Management of Traumatic Injuries CPG*[14])

8. After intubation of the trachea and verification of end tidal carbon dioxide, communication with the surgeon ensures that the operation proceeds in a timely fashion. **Placement of an orogastric tube** at this point may potentially decrease the risk of aspiration.

MAINTENANCE OF ANESTHESIA

- **Maintenance of anesthesia can be accomplished via an inhalational volatile agent or via a total intravenous anesthetic (TIVA).**[15] Both approaches must be carefully titrated to the hemodynamic profile while assuring adequate sedation/hypnosis and analgesia. Awareness during anesthesia and the acute pain response can be mitigated during TIVA by assuring that both a sedative hypnotic (e.g., Propofol, benzodiazepine) and an analgesic (e.g., narcotic) are being administered. Narcotic dose can be titrated to hemodynamics.
- **Adequate IV access** must be assured immediately (e.g., large bore peripheral IV, intraosseous, rapid infusion catheter (RIC), Cordis central line). Placement of additional IV access or an arterial line (if indicated for continuous monitoring of beat-to-beat blood pressure) can be undertaken without delaying the start of the operation.
- Sending **a baseline set of labs**, to include coagulation studies and base excess, at the start of the case can set a reference point for the remainder of the resuscitation. Consider validation of Point of Care (POC) testing (e.g., iSTAT values) with traditional laboratory assays. Ensure all laboratory equipment and POC equipment are maintained within the manufacturer's biomedical engineering standards.
- The maintenance of anesthesia and the resuscitation can be guided by following the trend in **mean arterial pressure (MAP).** While the ideal blood pressure is controversial, a MAP < 55 mmHg has been associated with acute kidney injury and myocardial injury during anesthetics for non-cardiac surgery.[16] Maintaining a MAP > 60 mmHg will facilitate end organ perfusion without exacerbating any unsecured bleeding.

- **Traumatic brain injury (TBI)** represents a unique situation in which isolated episodes of hypotension can worsen mortality.[17] It is, therefore, advisable to maintain systolic blood pressure > 110 mmHg in patients with documented or suspected TBI. (See *Neurosurgery and Severe Head Injury CPG*[18])

RESUSCITATION

NOTE: *See Damage Control Resuscitation CPG*[7]

- **Ratios of fresh frozen plasma (FFP): packed red blood cells (PRBC)** approaching 1:1 have been demonstrated to confer a survival benefit in military and civilian trauma patients.[19, 20] While the ideal ratio of FFP: PRBC remains somewhat controversial, it is fair to say early administration of plasma and platelets is appropriate for the trauma patient in extremis.[21] When available, use cold stored whole blood. Fresh whole blood may also be safely used. A more exhaustive discussion of damage control resuscitation is found elsewhere in the CPGs and is recommended reading for this subject. Communication with the surgical team regarding the progress of the resuscitation and the stage of the surgery is an important factor in overall success.

- **TXA** is a potent synthetic lysine derivative that functions as an anti-fibrinolytic. Administration of 2 gm of TXA IV/IO-ASAP or within 3 hours of injury has been demonstrated to improve survival in a highly powered, randomized trial of international trauma patients.[22] A survival advantage was also demonstrated with the use of TXA in military trauma.[23] A recent analysis of prehospital dosing strategies for TXA in moderate to severe TBI found a significantly improved neurologic function at 6 months with a 2 gm bolus given prehospital compared to a 1 gm bolus + 1 gm infusion or placebo for the subset of patients with confirmed intracerebral hemorrhage, and no difference in survival or complications for either dose or placebo for all patients treated based on prehospital Glasgow Coma Scale (GCS) 3-12.[24] In other work, when prehospital TXA was administered within 1 hour of injury to patients in severe shock there was a 30 day mortality benefit.[25] More detailed analysis of timing and dosing regimens is on-going, but in the meantime it is safe to administer an initial 2 gm bolus of TXA

- **Hydrocortisone** is a potent mineralocorticoid which can augment blood pressure during shock states when the hypothalamic–pituitary–adrenal (HPA) axis is suppressed and unable to mount an effective stress response. Administration of hydrocortisone 100 mg can improve vasopressor responsiveness in critically ill trauma patients.[26,27]

- **Hypocalcemia** must be avoided in massive blood transfusion. Hypocalcemia is often due to chelation of calcium by the citrate preservative in stored blood. Trauma patients can be hypocalcemic even prior to blood product administration.[28] Severe hypocalcemia (iCa <0.9), has been associated with higher lactate, lower pH and worsened mortality.[29 30] Administration of 1 gm calcium-can correct this potentially life-threatening hypocalcemia, and the hypotension associated with it. Consider following ionized calcium levels with POC chemistry analysis. If this in unavailable, then consider empiric administration of 1gm calcium after each 4th unit of blood.[31]

- **Use of vasopressors** in trauma is generally associated with higher mortality.[32] In one analysis evaluating trauma patients who received vasopressor support, vasopressin was found to be the only vasopressor in which the 95% confidence interval for mortality crossed unity, suggesting non-significance.[33] Vasopressin was further evaluated by in a randomized controlled trial in which trauma patients received a vasopressin bolus followed by an infusion. The vasopressin group required fewer blood products, had similar mortality and complication rates.[34] In cases of refractory hypotension, a vasopressin bolus (2-4 units) followed by infusion (0.04 U/min) can be given in concert with aggressive blood product administration.

- **Timely administration of antibiotics** can decrease the incidence of post-operative infections and is part of the anesthetic resuscitation. Consider agents that will be effective against skin flora (Gram positive organisms) or, in the event of bowel injury, gastrointestinal flora (anaerobes and Gram negative organisms).

The *Infection Prevention in Combat-Related Injuries CPG* identifies the optimal antibiotics for multiple clinical scenarios.

POST-OPERATIVE/EMERGENCE

- **Low lung volume ventilation** (6mL/kg) can decrease mortality in critically ill patients with the acute respiratory distress syndrome.[35] Even in patients who have not developed the acute respiratory distress syndrome; initiation of low lung volume ventilation can improve outcome. Consider initiation of low lung volume ventilation in the OR.

- **Communication with the next role of care** is vital to maintaining continuity of care. In the deployed setting this may entail a face-to-face conversation with the intensive care unit team, or a report transmitted to a critical care air transport team. (See *Interfacility Transport of Patients between Theater Medical Treatment Facilities CPG)* A detailed written report/anesthetic record documents the operative resuscitation and facilitates transition to the next role of care. Being immediately available in the post-operative period to answer any questions can clarify any issues that may arise.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All trauma patients who undergo surgery within 24 hours of arrival to first surgical role of care (includes all surgeries performed).
2. Patients who receive endotracheal tube/cricothyroidomy/tracheostomy before the initial surgery AND undergo surgical procedure at Role 2 or Role 3.

INTENT (EXPECTED OUTCOMES)

1. Anesthesia care is documented on an anesthetic record and uploaded to Theater Medical Data Story.
2. Trauma patients in the OR maintain a body temperature > 36˚C during surgery.
3. Anesthesia following major trauma will be induced and maintained with less than 20% drop in initial blood pressure.
4. Patients undergoing massive transfusion will receive blood products in 1:1:1:1 ratio (plasma:platelets:RBC: cryoprecipitate).
5. Calcium is administered to patients who have received: one unit and after every 4 units of red blood product transfused.
6. Antibiotics are administered to all patients prior to initiation of surgery incision.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have anesthesia record received.
2. Number and percentage of trauma patients who maintained a body temperature > 36˚C during surgery (as recorded on anesthesia record).
3. Number and percentage of patients who do not drop systolic blood pressure more than 20 mmHg during the first 15 min after induction of anesthesia.

4. Number and percentage of patients undergoing massive transfusion (>10 u RBC + whole blood with 24 hours after injury) who received blood products in an FFP:RBC ratio between 0.5:1 to 1:1.5 while in the OR (as recorded on anesthesia record).

5. Number and percentage of patients undergoing massive transfusion (>10 u RBC + whole blood with 24 hours after injury) who receive platelet or whole blood transfusion while in the OR (as recorded on anesthesia record).

6. Number and percentage of patients who received more than 1 units of blood products transfused who also received calcium (as recorded on anesthesia record).

7. Number and percentage of patients who received antibiotic before surgery or documented no antibiotic indicated.

DATA SOURCE

- Patient Record
- Department of Defense Trauma

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting frequency will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the Chief of Trauma or equivalent's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: TRAUMA ANESTHESIA CHECKLIST

BEFORE PATIENT ARRIVAL

- ☐ Room temperature > 30˚C
- ☐ Warm IV line
- ☐ Machine check
- ☐ Airway equipment check
- ☐ Emergency medication check
- ☐ Blood Bank notified to have blood available per unit SOP

PATIENT ARRIVAL

- ☐ Patient identified for surgery as soon as possible
- ☐ Blood Bank notified to deliver blood per unit SOP
- ☐ Ensure large bore IV or CVC access
- ☐ Monitors (SaO2, BP, ECG)
- ☐ Pre-oxygenation

INDUCTION

- ☐ Sedative hypnotic (Ketamine vs. Propofol)
- ☐ Neuromuscular blockade (Rocuronium vs. succinylcholine)

INTUBATION

(Per Airway Management CPG)

- ☐ (+) ETCO2
- ☐ Place orogastric tube

ANESTHETIC

- ☐ Consider TIVA
- ☐ (Volatile anesthetic and/or benzodiazepine) + narcotic
- ☐ Insert additional IV access and/or arterial line if needed

RESUSCITATION

(per Damage Control Resuscitation CPG)

- ☐ Send baseline labs, type and cross if not yet done
- ☐ Follow MAP trends
- ☐ Goal FFP: PRBC: Plt 1:1:1 if Massive Transfusion. Use Cold Stored Whole Blood (if available)
- ☐ Activate walking blood bank to obtain Fresh Whole Blood (if needed)
- ☐ Goal urine output 0.5-1.0 mL/kg/hr
- ☐ Consider TXA if <3 hours from injury and at risk for hemorrhagic shock
- ☐ Consider calcium 1 gm
- ☐ Consider hydrocortisone 100 mg
- ☐ Consider vasopressin 2-4 IU + 0.04 IU/min
- ☐ Administer appropriate antibiotics
- ☐ Special considerations for TBI as indicated in *Severe Head Injury CPG*

CLOSING/POST-OPERATIVE

- ☐ Low volume ventilation per *Acute Respiratory Failure CPG*

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of Department of Defense (DoD) policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion of off-label uses in CPGs is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion of off-label uses in CPGs is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, the DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Aural Blast Injury/Acoustic Trauma and Hearing Loss (ID:05)

This CPG will help the reader to quickly identify and treat aural trauma and hearing loss, to prevent morbidity, and to preserve as much function as possible – even while in the combat theater.

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INTRODUCTION

Acoustic trauma has continued to amass veteran disability at a 13-18% annual rate. Of the 2.35 million unique cases of auditory system disability at the end of FY 2013, approximately 870,000 are attributed to the Gulf War era and approximately 551,000 from exposure during operations in Iraq and Afghanistan.[1] Within the Department of Defense (DoD), 2% of the total force develops permanent injury annually, and 11-14% have unique episodes of temporary shifts in hearing. Historically, auditory injuries that are invisible and not life or limb threatening are not brought to the attention of medics, unless they are associated with other sever injuries, or are disabling in severity.[2]

The goal of this CPG is to elevate the awareness of noise threat, the prevalence of hazardous noise exposure, and the symptoms of acoustic trauma for purpose of facilitating early identification and early intervention of acoustic trauma. Improving outcomes for hearing requires developing a trusted surveillance and early referral and reporting system so that significant symptomatic exposures can be evaluated and diagnosed in a timely manner within therapeutic windows when intervention may mitigate injury progression, rather than current trends that put off consultations that delay care past the point of successful management. Improving the outcomes from acoustic trauma will preserve hearing capabilities in ranges conducive to continued high level function and performance.

INJURY OVERVIEW

For the purposes of this CPG, Service Members exposed to hazardous noise is impact noise or noise greater than (140dB) are at high risk for acoustic trauma and subsequent Hearing Loss (HL). Patients exposed to blasts are at risk for both aural and acoustic trauma.[(3-5)]

Hazardous noise causes injury to the hearing mechanisms in the inner ear. The symptoms of acoustic trauma are: hearing loss, tinnitus (ringing in the ear), aural fullness, recruitment (ear pain with loud noise), difficulty localizing sounds, difficulty hearing in a noisy background, and vertigo. Acoustic trauma may result in sensorineural hearing loss (SNHL) that is either temporary (temporary threshold shift, TTS) or permanent (permanent threshold shift, PTS). A TTS will resolve with time, while the time frame for hearing recovery is unique in every case, any SNHL that persists beyond 8 weeks after injury is most likely permanent and should be considered a PTS. There are no clinical predictors for which patients with a TTS will persist to develop PTS.

The ear, specifically the tympanic membrane (TM), is the most sensitive organ to primary blast injury (PBI). Blasts can perforate the TM. Risk of injury is determined by proximity to the source of the blast, as well as factors related to secondary, tertiary, and quaternary blast effects.[6] The signs and symptoms of a TM perforation include the signs and symptoms of SNHL as well as pain, bloody ear discharge, and conductive hearing loss (decreased ability to transmit sound through the middle ear to the inner ear,). TM perforations heal spontaneously in 80 to 94% of cases.[7] The smaller the size of the TM perforation, the greater the likelihood is of spontaneous closure. The majority of TM perforations that close spontaneously do so within the first 8 weeks after injury.[(8,9)] For these reasons, perforation rates in mass casualty situations may be under reported when limited resources are utilized for more significant polytraumatic cases. Because the tympanic membrane may be more at risk for damage than other body systems, it may likely be included in the non-immediate injuries deferred for later evaluation during which interval spontaneous healing may occur.[10] The more significant exposures are manifest in the immediate triage and may be the tympanic membrane perforations that are more refractory to spontaneous healing as noticed in the Boston marathon bombing where proximity to blast and significant nonotologic injuries were predictors of perforation.[11]

The ossicular chain may be injured as a result of PBI, with fracture of the ossicles or disarticulation of the chain, both of which can result in CHL with or without SNHL. TM perforations and middle ear injuries may heal with scarring that stiffens the ossicular chain also resulting in CHL. Blasts are noise hazards as well as explosive threats. The combination of a CHL with a SNHL is called a mixed hearing loss.

The temporal bone may also be fractured as a result of higher order blast injury, and these often are associated with secondary or tertiary blast effects.[12] Patients with temporal bone fractures may have lacerations in the ear canal or along the TM, resulting in either bloody otorrhea or hemotypanum (blood behind the TM).[13] They may also have SNHL or CHL, depending on the orientation of the fracture. A small number of these fractures (15%) will have an associated cerebral spinal fluid (CSF) leak.[14] These are termed CSF otorrhea (a leak from the auditory canal) or CSF rhinorrhea (a leak from the nose). The risk of meningitis within the first 7 days post injury ranges from 5-11%, but increases to as high as 88% if left untreated over time; therefore broad spectrum antibiotic prophylaxis and expert consultation are recommended.[(14-17)] Testing otorhinorrhea to distinguish between patients with bloody drainage containing CSF from those who have bloody drainage without CSF is insensitive unless assay for beta2-transferrin (a protein unique to CSF) is obtained, which is unlikely to be available in the deployed setting. Spontaneous closure of CSF leaks occurs in greater than 90% of cases, and is facilitated by bed rest – head of bed elevation - anti-strain precautions and stool softeners. Failures should be considered for lumbar drainage of CSF. Surgical management of CSF leaks should be considered in CSF otorhinorrhea that does not close with other measures.[18]

The facial nerve can be injured in temporal bone fractures.[19] Acute management of intratemporal facial nerve injury is to provide objective documentation of facial movement using the House-Brackmann grading scale.[20] Complete immediate paralysis of the face portends more significant injury to the nerve and should be referred for evaluation and possible surgical decompression to improve optimal outcomes for facial function. Significant weakness approaching complete paralysis will often recover completely. Incomplete or complete facial paralyses that preclude eyelid closure should be managed with measures that include eye protection (eye lid taping, ophthalmic tear substitutes and protective ointment). For significant facial pareses/paralyses, early administration of steroids should be provided if not contraindicated, and referral for management by an otolaryngologist is indicated.[21]

Dizziness expressed as unsteadiness or vertigo (spinning sensation) following a blast injury can be a result of traumatic brain injury, but is also often caused by injury to the inner ear, specifically benign paroxysmal positional vertigo (BPPV), damage to sensitive neuroepithelial rests within the inner ear, perilymphatic fistula, and other.[22] Other inner ear abnormalities may cause vertigo such as otic capsule violating temporal bone fractures, secondary infections of the inner ear or vestibular nerves, trauma induced endolymphatic hydrops, and activation of subclinical superior semicircular canal dehiscence.

EVALUATION & TREATMENT

All Service Members that develop **symptoms consistent with noise trauma** (acute tinnitus, muffled hearing, fullness in the ear) should be educated and directed to self-report for evaluation and possible treatment as soon as practicable. Patients exposed to hazardous noise occurring from exposure to battle (improvised explosive devices, rockets, and small arms fire) and all patients exposed to a blast should be asked specifically about hearing loss and tinnitus during their initial trauma evaluation, unless other more urgent treatment or mental status conditions do not allow. This should be documented as soon as safe evaluation permits. All patients presenting to concussion care centers should be evaluated for hearing loss and tinnitus. If there is debris in the External Auditory Canal (EAC) or in the middle ear (as seen through a TM perforation), treat the patient with a fluoroquinolone and steroid containing topical antibiotic (e.g., four (4) drops of ciprofloxacin/dexamethasone or ofloxacin in the affected ear three (3) times a day for seven (7) days). Do NOT irrigate the ear as it may provoke pain and vertigo, move debris medially in the canal and middle ear, and promote infection. Also, do not use any

topical drops containing aminoglycosides (i.e. the neomycin in Cortisporin) since these are ototoxic. Patients should observe strict dry ear precautions and keep ALL water out of the EAC until the TM perforation has healed or is repaired. Removal of debris should only be done by an ENT surgeon in order to avoid further injury to the EAC or the middle ear.

Hearing loss that persists 72 hours after acoustic trauma warrants a hearing test or audiogram. When hearing loss is present, individuals should be restricted from hazardous noise environments and kept on base, if possible. This is important to allow time for healing, and the inner ear is more susceptible to further noise-induced damage while it is under the oxidative stress and glutamate toxicity of an acute injury. A Service Member with hearing loss is less effective during missions and can negatively impact mission performance.

Vestibular trauma to the inner ear may manifest in vertigo. Please refer to the Veteran Affairs/DoD vestibular clinical recommendations for a detailed review of traumatic dizziness (http://hearing.health.mil/files/vestibclinpractrecs.pdf). All patients with positional vertigo and without other contraindicating injuries should undergo a Dix-Hallpike test, and an Epley or canalith repositioning maneuver if positive. (See Appendix A and Appendix B.)

ABSOLUTE INDICATIONS FOR SCREENING AUDIOGRAM (HEARING TEST)

All patients with subjective hearing loss and tinnitus following blast exposure should have the exposure documented, and should be evaluated by hearing testing as soon as possible. Hearing loss (either subjective or through screening audiograms) that persists for more than 72 hours after an acoustic trauma or blast injury warrants formal comprehensive hearing test or audiogram (including tympanometry, bone conducted thresholds, speech discrimination, and acoustic reflexes not evaluated by screening audiograms). Patients with TTS greater than 25 dB losses in three consecutive frequencies should be considered candidates for high dose oral and/or transtympanic steroid injections when not otherwise contraindicated. An oral steroid regimen of prednisone 60mg daily for 10 days followed by a two week taper, and transtympanic dexamethasone 24mg/ml repeating at 1-2 week intervals for up to three injections are warranted. Hearing response to treatment should be followed by audiometry, and additional injections guided by response to steroid. Patients with threshold shift greater than 60 dB on three consecutive frequencies for ten or more days after noise exposure are not likely to resolve spontaneously and are likely PTS losses. Hearing loss is detrimental to the patient's personal safety and effectiveness and may carry a comorbid vestibular deficit either clinically or sub clinically. Patients should be referred to ENT for evaluation and further testing. If ENT is not available in the specific Area of Operation (AOR), then patients should be evacuated to a higher level of care.

ABSOLUTE INDICATIONS FOR OTOLARYNGOLOGY (ENT) REFERRAL

- Temporal bone fracture with or without ear drainage.
- Persistent HL > 72 hours after acoustic trauma, or inability to perform duties due to perceived HL.
- TM perforation that has not resolved 8 weeks after injury. Referral for simple TM perforations without refractory drainage or significant SNHL should be delayed until 8 weeks after injury to allow for healing.
- Vertigo that does not resolve within 7 days after injury, even if episodic.
- Clear ear drainage.
- Persistent discolored ear drainage that does not resolve after 3 days of topical antibiotic steroid combination drop therapy.
- Facial nerve paralysis.
- On screening audiogram:

- Pure tone threshold average across 500, 1000, and 2000 Hz that is greater than 30 dB.
- Or any hearing threshold greater than 35 dB at 500, 1000, and 2000 Hz.
- Or any hearing threshold greater than 45 dB at 3000 Hz or 55dB at 4000 Hz.

Interpretation of the post-traumatic audiogram is facilitated by review of a baseline audiogram, if available.

RELATIVE INDICATIONS FOR OTOLARYNGOLOGY (ENT) REFERRAL

- Debris in the EAC that does not clear with topical ear drops.
- Inability to visualize the TM despite treatment with topical ear drops.
- Persistent dizziness, even if not true vertigo.
- Significant communication problems regardless of the hearing test results.
- Tinnitus that interferes with the patient's duty performance or lifestyle, regardless of hearing test results.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients exposed to a blast, and patients who develop symptoms consistent with noise trauma.

INTENT (EXPECTED OUTCOMES)

1. All patients with blast injury, with symptoms of acoustic trauma (e.g., tinnitus, vertigo, muffled hearing, and drainage from ear, fullness in the ear, blast injury or documented noise trauma) have documented tympanic membrane examination.
2. All patients with blast injury, with symptoms of acoustic trauma (e.g., tinnitus, vertigo, muffled hearing, and drainage from ear, fullness in the ear, blast injury or documented noise trauma) persisting greater than 72h have documented screening hearing test or audiogram.
3. All patients in the population of interest with absolute indications for ENT referral (per CPG) have a documented ENT evaluation.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have a documented tympanic membrane exam.
2. Number and percentage of patients in the population of interest with hearing loss persisting >72h who have a hearing test or audiogram.
3. Number and percentage of patients in the population of interest with absolute indications for ENT referral who have a documented ENT examination.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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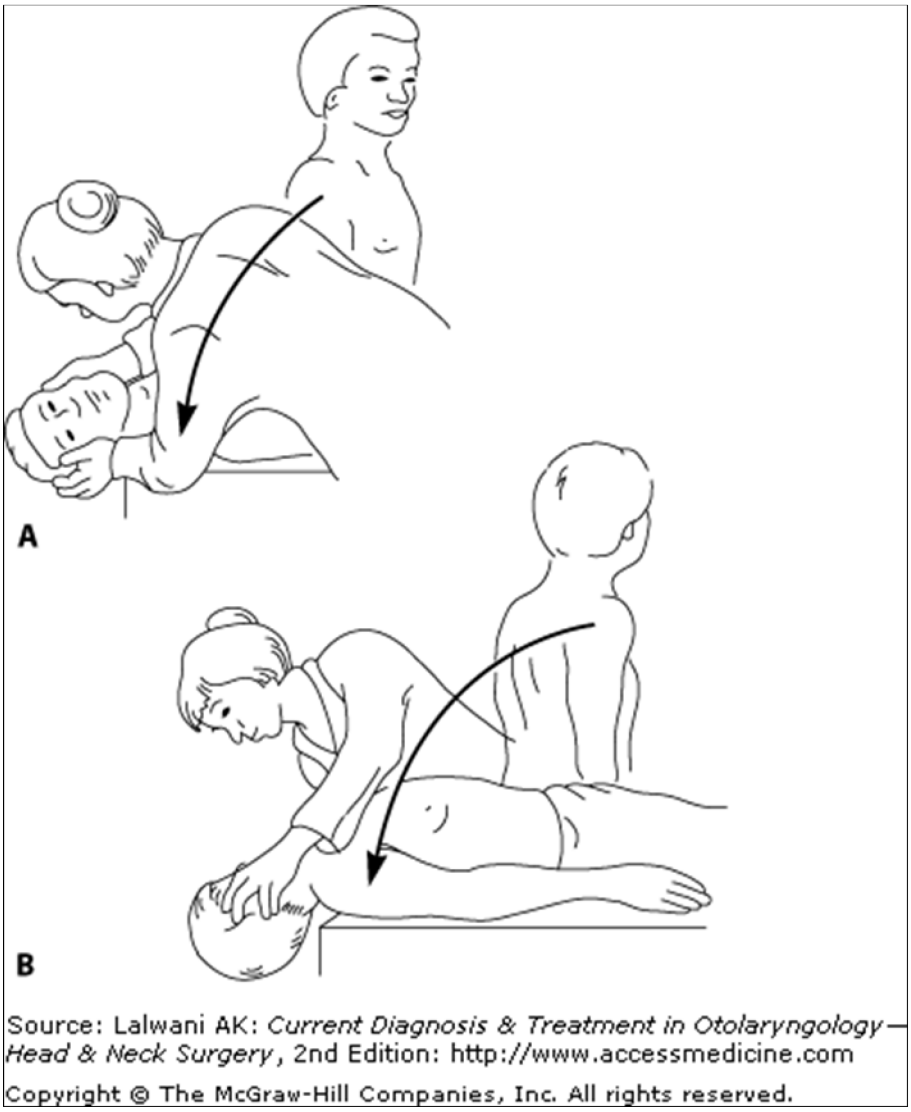
APPENDIX A: DIX-HALLPIKE TEST



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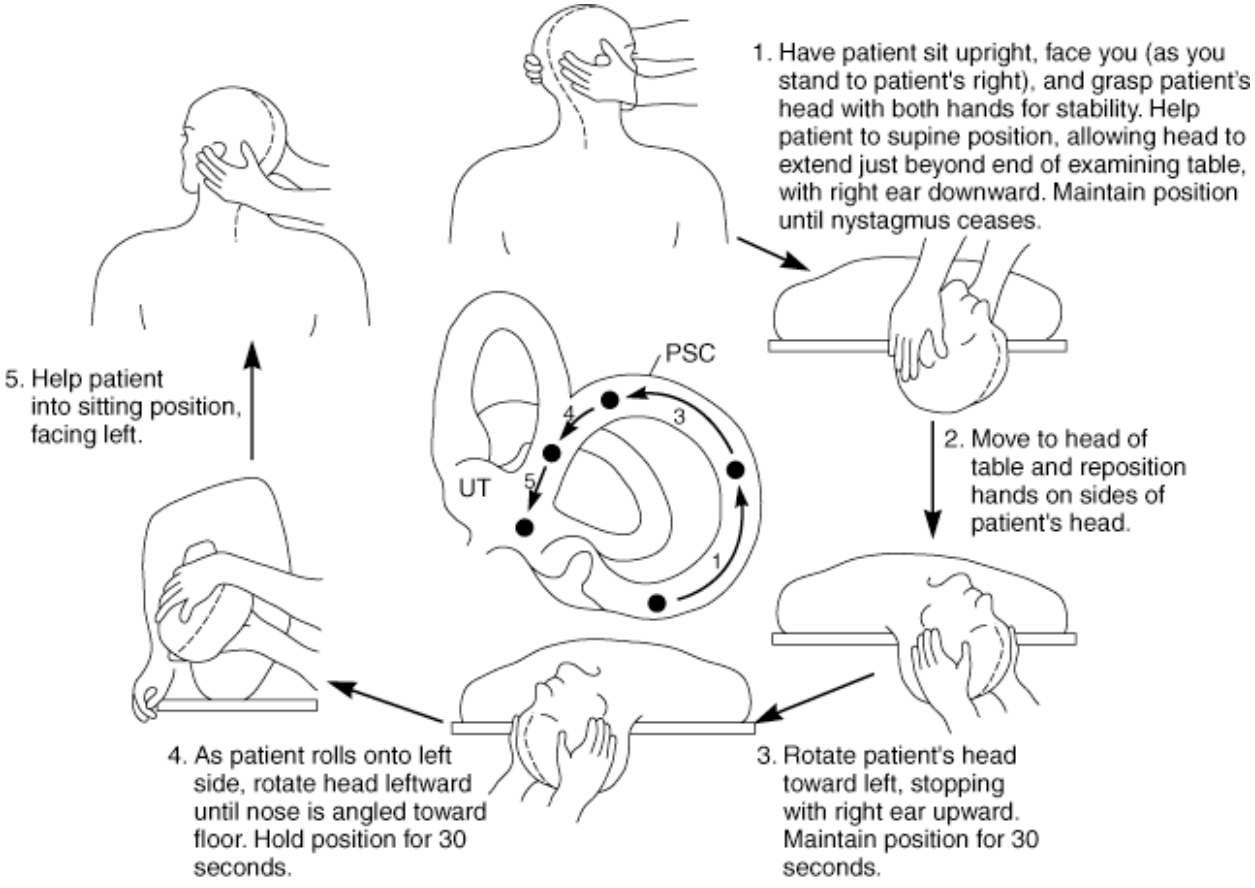
DIX-HALLPIKE TEST

A. For testing the right posterior semicircular canal, the patient sits on the exam table and turns his or her head to the right 45 degrees. This places the posterior semicircular canal in the sagittal plane. The examiner stands facing the patient on the patient's right side or behind the patient.

B. The patient is then moved by the examiner from the seated to the supine position with the head slightly hanging over the edge of the table. The right ear is down and the chin is pointing slightly up. The eyes are observed for the characteristic nystagmus.

APPENDIX B: EPLEY MANEUVER


1. Have patient sit upright, face you (as you stand to patient's right), and grasp patient's head with both hands for stability. Help patient to supine position, allowing head to extend just beyond end of examining table, with right ear downward. Maintain position until nystagmus ceases.
2. Move to head of table and reposition hands on sides of patient's head.
3. Rotate patient's head toward left, stopping with right ear upward. Maintain position for 30 seconds.
4. As patient rolls onto left side, rotate head leftward until nose is angled toward floor. Hold position for 30 seconds.
5. Help patient into sitting position, facing left.
PSC
UT
1
2
3
4
5

Source: Lalwani AK: *Current Diagnosis & Treatment in Otolaryngology—Head & Neck Surgery*, 2nd Edition: http://www.accessmedicine.com

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EPLEY MANEUVER

The patient is taken through four moves, starting in the sitting position with the head turned at a 45° angle toward the affected side.

A. The patient is placed into the Dix-Hallpike position (supine with the affected ear down) until the vertigo and nystagmus subside.

B. The patient's head is then turned to the opposite side, causing the affected ear to be up and the unaffected ear to be down.

C. The whole body and head are then turned away from the affected side to a lateral decubitus position, with the head in a face-down position.

D. The last step is to bring the patient back to a sitting position with the head turned toward the unaffected shoulder.

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Austere Resuscitative and Surgical Care (ARSC) (CPG ID:76)

This CPG provides guidance for Austere Resuscitative and Surgical Care (ARSC) teams.

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SUMMARY OF RECOMMENDATIONS & GUIDELINES

- The intent of this Clinical Practice Guideline (CPG) is to provide guidance for Austere Resuscitative and Surgical Care (ARSC) teams, which are often comprised of conventional forces surgical units employed in support of special operations missions.
- All ARSC teams should receive ARSC-specific, team-centric pre-deployment readiness training to include medical aspects and operational aspects of ARSC, with the result that ARSC teams are capable of protecting themselves and their patients and function well in a tactical environment.
- The purpose of the ARSC team is to mitigate risk for the Operational Commander by providing surgical and resuscitative care for combat casualties. ARSC teams are smaller and more mobile compared to other conventional surgical assets and have less clinical capability and holding capacity. Realistic assessment of the risks and benefits of this capability must be clearly communicated to the Operational Commander.
- Limited resources and staffing require that medical decisions are made in the context of the following variables: time and distance to the next role of care, capability of the next role of care, availability of blood products, sterility, anticipation of further casualties, evacuation capability, security, mobility, and patient holding capacity.
- Patient care must focus on rapid triage, initial resuscitation with blood products, rapid control of hemorrhage and contamination with a damage control approach, and subsequent transfer to higher echelon.
- Ultrasound of the chest and abdomen in patients with penetrating trauma to chest, abdomen, or pelvis or severe blunt trauma should be performed to rule out life threatening injuries.
- A ruck-truck-house model, listed below, can help frame logistical considerations for planning purposes to maximize mobility and flexibility.
- Documentation (e.g., JTS Austere Trauma Resuscitation Record, operative note) must be completed for all patients treated by ARSC teams and submitted to the JTS or uploaded into Theater Medical Data Store (TMDS).

INTRODUCTION

The intent of the CPG is to provide small, conventional surgical teams both operational and clinical guidance for this unique ARSC environment. Small teams from every service have been tasked with the mission of supporting operational units (usually Special Operations Forces [SOF]) in far forward environments. The ARSC environment utilizes surgical capability outside of the conventional doctrinal guidance. The development of this CPG is not indicative of JTS support for non-doctrinal use of ultra-small teams with limited capabilities, but rather to provide guidance for teams that are deployed in support of missions that require ARSC to facilitate the best outcomes for casualties managed by ARSC teams.

It is recognized that teams are working in the ARSC environment, frequently without specific training for the unique challenges, both clinical and tactical, that these teams encounter. Small surgical teams have been increasingly utilized and have an evolving role in providing care to U.S. and partner forces on the battlefield over the last two decades of global conflict. The Task Force Commanders or their designees will be referred to as the Operational Command to represent all services throughout this document. Operational forces place high value on the support of surgical capability in their area of operations and may be constrained by policy to perform forward military operations within defined evacuation rings. During the course of current conflicts, U.S. Army

Forward Surgical Teams (FST) and others were split into ever smaller elements and employed outside of published doctrinal concepts in order to meet operational demand for close surgical support,[1-7] often in support of SOF. The demand for smaller and more mobile surgical teams has continued to grow and many different models have emerged over the last two decades. Examples include: the Joint Medical Augmentation Unit Surgical Resuscitative Team; Army Expeditionary Resuscitative Surgical Team and split Forward Resuscitative Surgical Team; the Air Force Ground Surgical Team and Special Operations Surgical Team; Navy Damage Control Surgical Team and Expeditionary Resuscitation Surgical System.[1-11]

There is no standard definition or joint doctrine specifying the exact capabilities of these small surgical teams. While this CPG has been developed based on ground combat support, the concepts can be applied to maritime environments. Recently, the Austere Surgery Teams Sub-Committee of the JTS Committee on Surgical Combat Casualty Care defined the care environment of these small teams as, "Austere Resuscitative and Surgical Care is advanced medical capability delivered by small teams with limited resources, often beyond traditional timelines of care, and bridging gaps in roles of care in order to enable forward military operations and mitigate risk to the force."[12] The goal of this guideline is to provide guidance for the leaders and personnel of ARSC teams who are tasked to deploy and provide advanced medical and surgical capability on the battlefield spanning the spectrum from point of injury (POI) up to conventional Role 2; noting that this environment of care has nuances from conventional/doctrinal surgical support. These teams are often comprised of conventional forces personnel in support of SOF missions and have a unique placement in the battlefield system of care; their ability to support these teams and remain small and agile is reliant on the proximity and capabilities of adjacent roles of care.

ARSC MISSION READINESS

Expertise in trauma care is the cornerstone for ARSC teams and trauma training to achieve and sustain clinical expertise of all team members is foundational. Historic abbreviated 'just-in-time' training for trauma care is highly discouraged. Combat trauma patients already present the most demanding challenges to an experienced trauma team in the unconstrained environment. ARSC team members should be selected to possess a mission-first mindset, perform well under duress, work effectively as part of a team, and demonstrate resilience to periods of sustained levels of stress. Individual members should be proficient in TCCC and their respective specialties of resuscitative, surgical, and post-op care of critically-ill trauma patients. Ideally, ARSC teams will achieve expertise by working routinely as a team in high volume, high quality trauma centers in order to develop trust, fluid team dynamics, and to cross train on key roles and tasks in order to maximize use of limited available hands.

It has been well recognized that certain teams supporting these missions may not maintain the appropriate clinical volume for skill sustainment. This fact emphasizes two elements of the current trauma system in the DoD: (1) maintaining surgical trauma skills while not deployed (2) keeping deployments short for individuals with life-saving critical skills that have been demonstrated to be perishable. It is important that deployed clinical and operational leadership recognize the value of personnel flexibility (intra-theater rotations) to ensure that providers get clinical exposure during deployments.

ARSC teams should be prepared to function outside of the boundaries of forward operating bases; therefore, success relies on proper integration with the operational mission. The ability to balance resuscitative trauma care within the tactical mission requirements and constraints is the greatest challenge. ARSC teams should undergo training to function in tactical environments, including training in survival, evasion, resistance, and escape, and be proficient in tactical communications and weapons management. Specific guidance from the supported ground force should guide the training requirements. Personnel must have the ability to defend themselves and their patients. Teams require expeditionary maneuverability with a compact resuscitative

surgical package that is rapidly deployable and collapsible. Pre-mission tactical training for the team should be supported by hospital and ground force leaders and include technical skills and knowledge, team training, and professional development.

Employing ad hoc teams without specialized equipment or more intensive, sustained pre-deployment and team-centric training specific for this mission presents both a risk-to-mission and risk-to-force, and is highly discouraged.[3,13,14] Being an asset in the operational environment, and not a liability, requires that ARSC team members have sufficient training to integrate with the supported operational force and throughout the entire en route chain of care. The smaller the ARSC team, the more technical and clinical expertise is required for all team members. Likewise, the farther forward the ARSC team deploys, the more tactical and clinical proficiency the team requires.

Mission planning is essential to effective employment of the ARSC team and begins well before deployment. Surgeon involvement with ARSC leadership is essential. ARSC leadership elements include: the officer in charge (OIC), senior surgeon, and senior enlisted member –they should be involved in all phases of the Joint Operations Planning Process. Communicate early and often with the line command in order to establish mutual trust and shared realistic expectations of the ARSC team's capabilities, limitations, and requirements for each individual mission while deployed. The Operational Command must be advised by the OIC and/or senior surgeon of the decreased capability (as compared to a conventional Role 2) that ARSCs can deliver, and accept the increased risk to their forces. The Command must be aware of the number of critically injured casualties that can be managed before personnel are overwhelmed or resources exhausted. Dedicated security from anticipated threats must be provided when the ARSC team is decisively engaged in patient care. Successful integration of resuscitative trauma care within the operational environment begins before the first patient contact.

OPERATIONAL INFLUENCES ON CLINICAL DECISION MAKING

Expert clinical decision-making in the austere environment is the most important asset the ARSC provides. It is multifactorial and may differ from traditional Role 2 and Role 3 settings based on the operational context and the time and distance to the next role of care. Availability of resources, personnel, blood products, sterility, anticipation of further casualties, evacuation capability,[15,16] security, mobility, and patient holding capacity must all be considered. Additionally, the dynamic nature of the tactical environment may result in frequent changes and constant situational awareness is required. Assumptions on duration of transport and time to intervention at next level of care may increase the risk for the patient, the team, and the mission. Therefore, in the majority of cases damage control surgery should be done prior to transport of a casualty. A patient should never be transported from this environment with any question of instability if there is any uncertainly of the transport timeline.

Surgeons are responsible to communicate real-time clinical risk assessments regarding tactical conditions, operational constraints and potential impact on patient outcomes. However, surgeons must recognize that the operational commander retains legal decision-making authority to assume risk and to decide when operational objectives and tactical mission requirements supersede the recommended clinical course of action. Priorities may be weighed against the current threat situation, necessity for tactical maneuver, opportunities to accomplish mission objectives, etc. ARSC team integration in operational planning phases not only determines the medical plan but clarifies the overall tactical intent and the Operational Commander's desired end state. This allows the Operational Command and ARSC team to make timely decisions to accomplish objectives and maximize critical care capabilities.

TACTICAL COMBAT CASUALTY CARE

The TCCC guidelines are foundational knowledge for austere providers at all levels of training, and as of 2019 TCCC Training is a requirement for all medical providers. Thorough knowledge of current TCCC guidelines will not only help surgical teams understand care provided at point of injury, but will also provide battle-tested options for care that is appropriate in austere environments, even for surgical teams. A thorough understanding of tourniquets, their associated complications, and recommendations for conversion to pressure dressings and removal in the austere environment is fundamental to TCCC and is not common knowledge for providers without prior tactical medical experience. TCCC airway management, pain management, and resuscitation recommendations have been implemented with a high degree of success.

Mass casualty (MASCAL) scenarios are especially challenging in resource-limited environments. A small number of casualties can quickly turn into a MASCAL for the austere team. Mastery of the concepts of TCCC will save lives in this setting.[17-23] Principles of dynamic triage must be utilized during all phases of care, including intraoperatively, and not be limited to the initial evaluation.[13] Proper triage results in the greatest good for the greatest number. This cannot be overstated. The burden of these decisions is heavy. Redundancy in triage and clinical skills is especially necessary for ARSC teams given that they do not have all the resources of a standard Role 2 and because every member will be task saturated. Realistic, challenging MASCAL and triage scenarios should be trained during pre-deployment in order to work through difficult decisions based on limited resources.

Austere teams should maximize the use of limited resources by restricting surgical interventions to damage control only, particularly when evacuation timelines are short. When evacuation timelines are delayed, more definitive or repeat surgeries may be required. For example, a vascular shunt may temporize arterial injury, but when evacuation is delayed beyond 24 hours, definitive vascular reconstruction or amputation may be indicated. When transferring patients to a host nation facility, the capability for definitive surgical care may be absent or unknown. This highlights the wide and complex spectrum of clinical care in the austere setting and emphasizes the importance of understanding time and distance to the next level of care with a clear knowledge of the transport capability as well as the receiving facility's capability.

When evacuation is delayed and patients are held by a surgical team after the initial resuscitative care, the surgeon must weigh the risks of definitive surgery against the risks of ischemia and infection. There are currently not enough outcome data available to make firm recommendations for patients being managed more than 72 hours in an austere environment.

DAMAGE CONTROL PROCEDURES

ARSC teams exist for unstable patients who cannot tolerate transport to a Role 2 (or next level of care); their function in the battlefield continuum of care is for the provision of early damage control resuscitation and surgery. ARSC teams should focus damage control principles as the primary approach for all surgical procedures which minimizes time, resources and personnel. This mindset and approach should be used for both traumatic and non-traumatic patients (such as appendicitis). There may be scenarios where the ARSC team will be the definitive level of care for host nation patients, however decision-making is still constrained by resource availability and by operational mission requirements.[24]

In most cases, emergency surgery for acute surgical diseases (e.g., acute cholecystitis and appendicitis) that do not clinically require a damage control strategy, should be temporized with antibiotics and expeditiously transferred to a higher level of care. If operational considerations require patients be held more than 24 hours,

or if the patient presents with sepsis or hemodynamic instability due to an intra-abdominal source, surgery may be indicated.

For elective or semi urgent cases, the evacuation chain should be utilized in communication with the operational commander and the theater trauma director. Give the significant resource limitations, only true emergencies should be considered at this level of care.

ANESTHESIA AND INTRAOPERATIVE MONITORING

Delivering safe anesthesia in the austere environment must account for available medical capabilities and the tactical situation.

Patient Monitoring

Monitoring under anesthesia ideally includes understanding normal physiology of a patient and using your hands and eyes to monitor your patient. Adjuncts in this environment are additional cardiac monitoring, blood pressure, pulse oximetry, temperature, and for a ventilated patient, inspired oxygen analysis and end-tidal carbon dioxide (ETCO2) measurement.[25] A range of devices are available to monitor vital signs with minimal space and maintenance. However, honing clinical skills to manually assess vital signs is important as monitoring devices may not always be available.

ETCO2: ETCO2 monitoring is an important capability as a physiologic indicator, even at the initial levels of care. The ETCO2 value is relevant during resuscitation and in TBI patients, in addition to its established role in verifying airway placement and monitoring ventilation.[25] Under controlled ventilation, the ETCO2 level can also be used to estimate changes in cardiac index, or cardiac output over time.[26] This knowledge can be applied within the clinical context, and can be used in cardiopulmonary resuscitation to predict patients who are more likely to achieve return of spontaneous circulation (PETCO2 >10mm Hg).[26] As such, ETCO2 can be useful during triage.

Ultrasound: The presence of sonographically identified cardiac activity at any point during trauma bay or intraoperative resuscitation is associated with increased survival to hospital admission.[27]

Invasive pressure monitoring: Small in-line devices (i.e. Centurion Compass®) have been used successfully for monitoring aortic occlusion during Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA). These can also be used to measure and trend central venous pressures, bladder pressures, or myofascial compartment pressures. See JTS Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for hemorrhagic shock CPG, 06 Jul 2017.[28]

Perioperative Anesthetic Considerations

Definitive airway control is challenging in the trauma patient. It becomes increasingly difficult in the austere environment and requires a significant commitment of resources such as the need for a ventilator, continuous monitoring and sedation. When intubation is indicated, the timing should be optimized in order to conserve resources. Even with depressed Glasgow Coma Scale, if a patient remains spontaneously breathing, it may be preferable to support their respirations non-invasively while resuscitation is initiated. Resuscitation prior to induction of anesthesia in an unstable patient may prevent hemodynamic collapse. Alternative anesthetic techniques such as moderate sedation or peripheral nerve block may conserve resources. With respect to airway management, consider the capabilities of the transport personnel, their available respiratory and monitoring equipment en route, and the capability of the next level of care. In patients with a potential for airway compromise, ensure a definitive airway is established prior to transport. Considerations must be made

for supplemental oxygen delivery which can be challenging in this environment, an Austere Anesthesia CPG (under development) will address these issues specifically.

Maintenance of Anesthesia

The means to administer inhaled agents for the maintenance of anesthesia is not likely to be available in the austere setting. Electrical power and inspired gases used to drive vaporizers are problematic resources to obtain. Draw over methods could be considered, however can be challenging to titrate or administer when considering variables such as a non-spontaneously breathing patients or patient transportation. General anesthesia using a total intravenous anesthetic (TIVA) is a more effective means to provide adequate anesthesia and conserve equipment and resources. Practitioners should have an intimate knowledge of the benefits and limitations of intravenous anesthetic drugs available to allow for an effective, balanced anesthetic. Simple infusion pumps or quantitative drip sets can automate flow for prolonged infusions and providers should carefully select and train with their specific equipment. Since TIVA is commonly utilized in this environment, calculations and concentrations of the most commonly used drips have to be mastered by providers using this form of sedation and general anesthetic and the drip rates of Propofol, Fentanyl and Ketamine have to be well understood.

Regional Anesthesia Adjuncts

The capability to perform regional anesthetic techniques enhances the ARSC team mission. Experience in Iraq and Afghanistan has highlighted the value of early aggressive pain management in the combat casualty,[29] and reinforced the importance of multimodal pain management in the perioperative setting.[30,31] The use of regional anesthesia, either in conjunction with or instead of general anesthesia, may reduce the resources and personnel required for operative, postoperative, and subsequent en-route care. The risk of masking a developing compartment syndrome must be considered. Ultrasound or stimulator-based techniques can be used to perform a variety of nerve blocks. Intercostal nerve blocks can be used to decrease respiratory pain associated with thoracostomy tube or thoracotomy or multiple rib fractures.[32] A transversus abdominis plane block can be used as a part of multi-modal pain treatment to attempt early extubation after laparotomy, even in patients with a temporarily closed abdomen.[33]

Blood Transfusion Capability

In addition to surgical hemorrhage control, resuscitation with warmed blood is the most important intervention that the ARSC team can perform. Effective resuscitation of the trauma patient who has sustained massive blood loss consists of simultaneous hemorrhage control along with resuscitation to correct trauma-induced coagulopathy, acidosis, and hypothermia.[33] Resuscitation with blood products rather than crystalloid or vasopressor administration is the standard in trauma care; calcium administration should be early during the resuscitation. Treatment of acute coagulopathy of trauma is addressed with transfusion of whole blood, plasma, cryoprecipitate, and platelets, however blood products in the austere environment may be limited and platelets and cryoprecipitate will unlikely be available. Whole blood administration, preferably stored low titer type O whole blood (LTOWB), provides the most balanced resuscitation and is easier to administer as a single product for minimally staffed ARSC teams. The capability to draw warm fresh whole blood from prescreened donors should be optimized. Also, the capability to warm blood products during massive resuscitation is required, although there is not always standardized equipment to support this requirement, every effort should be made to ensure these teams deploy with at least 1 rapid fluid infuser with warming capabilities. Effective rapid transfusion and warming devices are necessary and require adequate power to support.

In general, an ARSC team should plan to ideally maintain at least 20 units of whole blood or red blood cells (RBCs) + plasma (20 of each blood component). Mission requirements will also dictate inventory levels of blood (mission support vs. area support). The ARSC teams must be in regular communication with the theater Joint

Blood Program Officer (JBPO) or Armed Service Blood Program Theater representative and keep their status updated (as much as possible) in TMDS to facilitate resupply. ARSC teams must have a well-rehearsed walking blood bank (WBB) capability. At times the WBB may rely on host national blood depending on the tactical and clinical environment. If using host nation blood supply, consideration must be given to endemic disease risk of donors and ability to perform rapid tests to mitigate risk. When supporting en route care missions, WBB is less feasible and stored blood is required depending on operational activity. Frequent communication with the supporting Blood Support Detachment and JBPO is essential.

SURGICAL AIRWAY MANAGEMENT

Airway obstruction represents 8% of potentially preventable prehospital deaths.[34] Multiple attempts at orotracheal intubation should be avoided, and providers should maintain a low threshold to surgically manage the airway. Complex facial injuries require airway management and hemorrhage control for temporary stabilization.[35] In this circumstance, obtaining an initial endotracheal tube or cricothyroidotomy is appropriate. As above, consider the level of the transport capability. Transferring a patient with significant maxillofacial injuries with a surgical airway as opposed to an orotracheal airway may be the safest option. It is important to have equipment for a surgical airway ready in the event that orotracheal intubation is unsuccessful. Always confirm airway placement with ETCO2.[36] See JTS Airway Management of Traumatic injuries CPG, 17 Jul 2017.[37]

NECK INJURIES

Hard indications for surgical neck exploration in the ARSC environment are no different than at the Role 2 or Role 3 and include 'hard signs' of vascular injury with active hemorrhage or expanding or pulsatile hematoma. However, because of the lack of imaging, lack of resources and the inherent challenge of these injuries – casualties without hard signs, should be transferred to a higher level of care as long as they have an acceptable airway for transport (this could be their native airway or a definitive airway). In some cases, exploration is indicated when airway injury is suspected based on subcutaneous emphysema or air bubbling through the wound,[38] however many cases of tracheal injury can be temporarily managed with endotracheal intubation with the cuff inflated below the level of injury. Be ready to immediately perform a surgical airway in these patients, as a relatively stable patient may have significant airway disruption. Proximal and distal vascular control is difficult for injuries approaching the base of the neck or skull base. In this environment, most penetrating wounds to the neck without immediate life-threatening hemorrhage should be transferred to a higher level of care for further diagnostic workup and subsequent formal surgical exploration. While penetration of the platysma alone is not an indication for neck exploration in the austere environment in the current trauma system, multiple factors must be taken into consideration (transport time, capabilities at sending and receiving facilities, the trauma system) as the level of injury may be difficult to ascertain without imaging. Maintain a low threshold to secure the patient's airway prior to transfer. Additionally, communication to the higher level of care should be established to discuss the plan for these casualties.

TRAUMATIC BRAIN INJURY

Non-neurosurgeons should be cautious when performing craniotomy or craniectomy in the austere setting, this is no different from a surgeon at a Role 2. However, in this far forward environment, medical management and craniectomy have even more challenges. Lack of appropriate training and experience may make operative therapy more dangerous than medical management alone. In the austere setting, every attempt should be made to maximize medical management (i.e. ETCO2 monitoring, hypertonic saline, bed positioning, airway management, sedation, paralysis, keeping the head elevated and midline. Discuss the patient with and transfer to a neurosurgeon as soon as clinically possible.[39] If transport is not possible, the provider should attempt to

seek the guidance of a neurosurgeon in real time. In the absence of proper imaging, burr holes or needle drainage of suspected epidural hematomas are discouraged. See JTS Emergency Cranial Procedures by Non-neurosurgeons in Deployed Setting CPG, 23 Apr 2018.[40]

OPHTHALMOLOGY

Trained ophthalmologists are never available in this environment and every attempt should be made to contact an ophthalmologists at the Role 3; however, given the nature of the ARSC teams, communication is not always feasible. Injuries to the globe should be covered with an occlusive shield and parental antibiotics and anti-emetics should be administered. These patients frequently experience severe nausea; oral medications should be avoided. It is imperative to avoid pressure to the globe, ensure nothing is directly touching the injured globe, and no intraocular medications are administered. See the JTS Ocular Injuries and Vision-Threatening Conditions in Prolonged Field Care CPG, 01 Dec 2017.[41] Lateral canthotomy and cantholysis should be performed if there is concern for retrobulbar hematoma or increased intraorbital pressure. In the rare circumstance that Telemedine support is available, it should be heavily utilized. Establish telemedicine consultation as soon as possible. AD.VI.S.OR, the Advanced VIrtual Support for OpeRational Forces system offers 24/7/365 on-demand real-time telemedicine consultations. https://prolongedfieldcare.org/telemed-resources-for-us-mil/

TORSO TRAUMA

Approximately 13% of combat casualty patients presented with injury patterns at risk of non-compressible torso hemorrhage (NCTH), and this was identified as a cause of death in 50-70% of patients assessed to have potentially survivable injuries in Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF).[35,42-44] Truncal injury was characterized as 36% thoracic and 64% abdominopelvic.[35] It is in this patient population that forward-positioned surgeons have the greatest potential to directly impact survival.[45-48] The ability to perform Extended Focused Assessment with Sonography for Trauma (E-FAST) for identification of intra-thoracic injury and intra-abdominal hemorrhage is required because X-ray and CT scan may be unavailable. Ultrasound has its limitations and has been documented as having a higher false positive and negative rates in penetrating trauma. In one study looking at combat trauma, FAST only had a sensitivity of 12% for intraabdominal injury requiring laparotomy;[49] this underscores the use of training to improve diagnostic sensitivity, as well as the challenges of these teams that do not have any additional diagnostic imaging. Diagnostic peritoneal lavage/diagnostic peritoneal aspiration (DPL/DPA) can be used to augment diagnostic capability when FAST results are equivocal, although DPL/DPA are only limited to evaluation of the peritoneal cavity. ARSC teams have to optimize requirement for ultrasound capability and providers must have the appropriate U.S. training. U.S. is limited for identification of pelvic or retroperitoneal hemorrhage, therefore a high index of suspicion should be maintained when the injury mechanism indicates potential retroperitoneal bleeding.

Although not proven with prospective outcome data, REBOA has shown potential in the austere environment as a bridge to prompt surgical intervention, to obtain rapid proximal vascular hemorrhage control, reduce blood transfusion requirements, improve exposure by reducing hemorrhage, facilitate rapid normalization of hemodynamics,[50] and as a force multiplier during MASCAL scenarios.[51,52] Early femoral arterial access (18 gauge A-line, 4 or 5 Fr. micropuncture) and monitoring can help identify patients who will die from hemorrhage earlier. Placing arterial access is strongly encouraged and does not require placement of a REBOA, but improves monitor. This can be upsized to the 7 Fr femoral sheath for balloon occlusion should the patient deteriorate. The sheath may be left in-situ connected to a pressure monitor during evacuation to higher levels of care or if repeat catheterization is probable, but comes at a risk of limb ischemia and even limb loss. Sheath complications are not uncommon and the sheath should be removed at the earliest time after the patient has demonstrated stability. After sheath removal the vascular must be evaluated to ensure that there is good distal perfusion.

While the sheath is in place, distal pulses must be followed closely. See the JTS Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock CPG, 06 Jul 2017.[28] All ARSC providers require REBOA training. There are multiple training courses available.

Laparotomy

Concern for NCTH with hemodynamic instability requires surgical intervention at the earliest opportunity that resources and personnel permit, this is no different from other roles of care. Damage control laparotomy is the standard in the unstable trauma patient and may be performed in forward environments.[13],[53] In the deployed setting, damage control surgery and temporary abdominal closure are recommended when significant intra-abdominal injuries are found.

In OIF and OEF, the rate of non-therapeutic laparotomy was as high as 32%.[54] A non-therapeutic laparotomy is likely safer than a potentially prolonged transfer in a casualty that might have a missed injury. These decisions are very challenging, but succumbing to injuries in flight is never acceptable. Selective non-operative management[55] should only be considered where CT scan, as well as, extended observation are possible.

Thoracotomy

The incidence of thoracic trauma in modern conflict is approximately 5%, with mortality ranging from 12%-24%.[44,56] Patients with severe thoracic trauma have a significant survival advantage if they reach surgical capability within one hour or less.[57-58] Thoracotomy should be performed when indicated with the damage control mindset and the goals of rapid control of hemorrhage and contamination. The chest may be temporarily packed and closed over chest tubes.

Cardiac Injury

Imaging is usually limited to a handheld ultrasound. Maintain a low threshold to perform a subxyphoid or transdiaphragmatic pericardial window if the injury pattern is concerning for mediastinal or cardiac injury. If there is blood in the pericardium, explore as indicated. See the JTS Wartime Thoracic Injury CPG, 26 Dec 2018.[59] Rarely, some patients with hemopericardium may present with normal hemodynamics which may represent a superficial injury to the myocardium and sternotomy may be avoided if the pericardial space is irrigated with warmed fluid, and the bleeding is noted to have stopped.[60-62] Place a closed suction drain and record output. A period of observation is recommended prior to transfer.

VASCULAR

Like every deployed surgeon, the ARSC surgeon should have training and experience in expeditious exposure of all named vessels to identify and control hemorrhage. The initial damage control and stabilization of injured vessels includes control of exsanguinating hemorrhage, recognition of extremity ischemia, rapid restoration of flow to the ischemic limb with vascular shunts, and fasciotomies to treat or prevent compartment syndrome.[13,62] All of the above, is exceptionally more difficult in the ARSC environment, emphasizing the importance of readiness and training for this skill set prior to deployment.

Shunt placement is a required skillset. When placing a shunt, thrombectomy of the distal vessel should be performed prior to shunt placement if vigorous back-bleeding is not present. Secure all shunts with suture as close to the vascular injury as possible to preserve native vessel length. Leaving all vessel loops used for proximal and distal control loosened and in place will allow the next surgeon to quickly identify relevant anatomy and provides rapid control of a vessel if the shunt dislodges in transport. Cover the operative field with dressings, and consider a temporary skin closure to protect the shunt. Primary patency rates are high for proximal shunts

(86%) and low for distal shunts (12%).[62] Primary repair of partially injured vessels, such as large veins, is preferable if greater than 50% stenosis can be avoided. Shunting of large veins is preferable to ligation when primary repair is not feasible and may increase patency rates of associated arterial shunts. Definitive reconstruction such as vein graft should be delayed to a higher level of care when possible.[13] If the vascular repair is associated with a fracture, immobilization with an external fixator is recommended; external fixation prior to definitive vascular shunting is recommended if the warm ischemia time allows. In the case of popliteal and femoral artery injuries, the use of shunts as opposed to primary amputation, even in an unstable patient, does not increase risk of death and improves overall amputation free survival.[63-64] Balloon catheters (REBOA or Fogarty) can be employed to provide temporary vascular control. Refer to the JTS Vascular Injury, 12 Aug 2016.[65]

Subclavian Vessels

This injury pattern carries a high mortality rate. Most venous bleeding and some arterial bleeding can be controlled with wound packing. A temporary skin closure over the packing may improve tamponade. Maneuvers to obtain proximal vascular control include intrathoracic exposures such as sternotomy, supraclavicular, clavicular resection, trap door approaches as well as retrograde placement of Fogarty catheter through the brachial artery or through the zone of injury. Additionally, inflating a Foley balloon within the wound track may provide tamponade, particularly if able to maintain compression against the clavicle or chest wall. A chest tube should be placed on the same side as the subclavian vascular injury if there is a concern for intrathoracic hemorrhage.

Inguinal Vessels

Contralateral placement of a REBOA catheter with aortic occlusion in zone 3 is a rapid and effective way to obtain temporary proximal control of a junctional groin injury. Extraperitoneal control of the iliac vessels above the level of the inguinal ligament also achieves proximal control of the injured vessel outside of the zone of injury, but a low threshold for intra-abdominal proximal control should be applied, given the often unpredictable trajectories of combat injuries.

Fasciotomy

Maintain a low threshold to perform fasciotomies for the combat injured extremity.[13] Delay in diagnosis of compartment syndrome can occur due to multiple patient handovers during the transport process.[13] Be proficient with techniques for both the upper and lower extremity – especially the common pitfalls: missing the deep posterior compartment in the lower extremity and not coming all the way across the carpal tunnel in the upper extremity. Even without evidence of compartment syndrome, early prophylactic fasciotomy may be considered in the setting of vascular injury with a temporary repair and may improve limb salvage rate, especially in patients who are going to be transported and do not have immediate access surgical care.[66]

EXTREMITY TRAUMA

Extremity trauma is the most common injury on the battlefield. Having proficiency with bony, soft tissue and vascular techniques in the extremities is extremely important for the ARSC surgeon – not always thoroughly trained in general surgery residencies. The austere surgeon must be familiar with all open surgical and non-surgical techniques to control hemorrhage and re-perfuse injured limbs. Transport of a patient with a tourniquet should be avoided. When tourniquets are left in place for more than 4-6 hours, the risk of severe rhabdomyolysis, kidney failure, limb loss, and death are high.[67] Closed reduction, splinting, and/or traction are often adequate temporary stabilization techniques of long bone fractures if these procedures adequately align the bony injury.

External Fixation

For combined orthopedic and vascular injuries, consider external fixation of long bone fractures after shunting and prior to definitive repair. Pelvic binder placement is effective for temporary control of most pelvic hemorrhage.[68] In delayed evacuation scenarios, pelvic binders should optimally remain in place no longer than 48-72 hours.

Mangled Extremity

Every effort should be made to temporize the mangled extremity and transfer the patient to a higher level of care. However, when blood product and resource availability are limited, limb salvage may not be feasible. Initial management of the mangled extremity includes hemorrhage control, irrigation, and debridement of clearly non-viable tissue. Traumatic amputations should not be formalized in the austere setting, though familiarity with formal amputations is required in order to anticipate future soft tissue coverage needs. Wounds should be left open in anticipation of repeated exploration and debridement. See JTS Amputation: Evaluation and Treatment CPG, 01 Jul 2016.[69]

Soft Tissue Wounds

Early debridement of soft tissue wounds and burns improves outcomes and morbidity. However, the ability to fully debride soft tissue wounds may be limited in the ARSC setting because of limited access to surgical energy devices, blood products, sterility, and irrigation fluid. Aggressive management of soft tissue injuries should be weighed against the available resources and operational considerations such as resupply and overall sustainment of the mission. In general, the ARSC team is not resourced to manage large soft tissue wounds that require serial debridement. Potable water is as effective as sterile fluid for surgical irrigation.[70] Sharp debridement is the standard of practice for soft tissue wounds. Commercial negative pressure dressings are unlikely to be available in the ARSC environment. Standard gauze (or hemostatic gauze) or occlusive dressings over closed suction drains are suitable for transport. See JTS Initial Management of War Wounds CPG, 25 Apr 2012[70] and JTS Acute Traumatic Wound Management in the Prolonged Field Care Setting CPG, 24 Jul 2017.[71]

ADDITIONAL CONSIDERATIONS

RESUSCITATION

Large bore IV access is one of the most critical components of initial resuscitation. With the IV stick, blood is used for Typing on an Eldon Card. All team members should be proficient in peripheral IV and IO placement. Initial resuscitation through an IO can be a bridge to IV placement. The DCR CPG algorithm should be followed for resuscitation. See the JTS Damage Control Resuscitation, 12 Jul 2019.[72] Ultrasound guided peripheral IV placement is another useful option. Additionally, it is recommended to become familiar with conversion of peripheral IV catheters to Rapid Infusion Catheters (Arrow RIC®). Central line access should be considered only when peripheral IV or IO access is limited or when multiple sites for infusion are not readily available. The majority of patients can be rapidly resuscitated through large bore peripheral IV or IO access. Rapid blood typing as part of the Walking Blood Bank, blood product storage, transfusion, and efficient blood warming are essential capabilities of ARSC teams.

BURNS

Protect the airway early; early intubation is necessary in patients with >40% TBSA burns, facial burns or this there is any concern for inhalation injury. Video laryngoscopy (i.e. GlideScope®) should be heavily utilized to obtain and early definitive airway and may help diagnose inhalational injuries in patients with facial burns. Burn resuscitation should be started as early as possible using the rule of 10s. See JTS Burn Care CPG, 11 May 2016.[73] The volume of IV resuscitation fluid available may be limited. Plasma may be used to supplement resuscitation fluid. Significant burns should be transferred rapidly to the next level of care. Maintain a low threshold to perform escharotomy early in the transport process, especially with circumferential full-thickness burns. Silverlon® is a lightweight burn dressing that can stay in place 3-5 days and is useful for other abrasions and shallow wounds as well. When burn dressings are not available, avoid debridement of blistered partial thickness burns and cover burns with dry sterile dressings. Maintain normothermia as burn patients are susceptible to hypothermia even in the warmest environments. Notify the USAISR Burn Center as early as possible (DSN 312-429-2876) or email: usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil.

HYPOTHERMIA

Maintenance of normothermia is crucial for survival of combat casualties. Active warming or cooling devices such as heaters or air conditioners have significant electrical power or fuel requirements and will not be available in the ARSC environment. Hypothermia management kits (HPMKs) should be frequently used, they contain chemical warming blankets that generate heat on exposure to air—these blankets should not be placed directly on the skin due to the risk of thermal burns. Hypothermia in the trauma patient is directly related to degree of blood loss. Hypothermia will continue until adequate blood volume is restored.

PEDIATRICS

ARSC teams may be required to care for pediatric patients including neonates, depending on the Medical Rules of Eligibility. This is a significant challenge for these teams; however, even though non-doctrinal, the unique mission requirements of these teams may result in them caring for pediatric patients. If this is the case, ensure age-specific medical supplies and equipment are available such as pediatric monitors, lines, tubes, and medications. While a Broselow bag may be too large to carry in this environment, they can be broken down and specific elements such as airway adjuncts and a Broselow™ tape can be carried to assist with caring for the pediatric population.

OBSTETRICS

Pregnant patients may present who meet medical rules of engagement for care. ARSC providers should be familiar with the anatomical changes that occur during pregnancy due to the gravid uterus. Ultrasound can be used to evaluate the fetus. Fetal distress is associated with a fetal heart rate of less than 100 beats per minute and is an indication of the need for continued maternal resuscitation, or even emergent fetal delivery. ARSC providers should be familiar with emergent obstetric procedures including cesarean section and surgical management of post-partum hemorrhage. ARSC providers should contact an obstetrician for guidance as able.

K9 DAMAGE CONTROL

Injured military working dogs (MWDs) may require urgent surgical stabilization. The MWD CPG, 12 Dec 2018.[74] outlines the unique clinical considerations for these patients. Always apply a muzzle (or improvised muzzle) early for safety. Consider having hair clippers and larger ET tubes (9-11 Fr) available for canine use as well as larger laryngoscopes (i.e. Miller blade size 4). The canine handler, unless injured, will help manage the care and will

have a card with weight-based medication doses specific to their canine. Standard tourniquets may be used for severe canine limb injuries, however elastic pressure dressings are typically effective and in some cases the tourniquets may not adjust to a small enough circumference to occlude blood flow. Predeployment MWD specific medical training is strongly recommended and in currently is a CENTCOM theater requirement. New recommendation regarding the K9 WBB exist and these teams (as well as all Role 2 and Role 3) should contact a theater Veterinarian when arriving in theater. If K9 blood is held on sight, then it must be in a separate cooler and location than human blood.

VENTILATOR MANAGEMENT

All team members should be facile with the use of the particular ventilator available. Refillable oxygen storage (liquid or gas) are heavy and a challenge to maintain and refill. Portable battery powered oxygen concentrators are an option but require power for continuous use. Additional ventilator management such as setting up an oxygen reservoir for a ventilator will be addressed in a future Austere Anesthesia CPG.

IMAGING

X-ray or cross-sectional imaging may not be available in the austere environment. Portable sonography may be the only imaging tool and miniaturized devices are available. Readiness and training for this skillset are required prior to deploying to an ARSC environment. Ultrasound will provide the ability to evaluate the torso for injuries (E-FAST), guide resuscitation, guide vascular access, assess for vascular flow, and to perform regional anesthetic techniques.

EXTERNAL ELECTRICAL POWER

The ability to provide quality care will depend heavily on electrical power. Early initiation of warmed blood products and patient normothermia are vital components of a successful trauma resuscitation. Maintenance of blood refrigeration and active warming and cooling devices (e.g., heaters, air-conditioners, blood warmers, plasma thawing devices) draw significant electrical power requirements. Regular maintenance and fuel requirements for power generators must be preplanned and communicated with the ground force commander, but are ultimately the responsibility of the surgical team.

CHEMICAL, BIOLOGICAL, RADIOLOGICAL AND NUCLEAR (CBRN)

ARSC teams should be prepared to protect and decontaminate themselves and there must be a plan for the patients and incoming casualties. While ARSC teams must have a treatment plan in place should they encounter a CBRN patient, they may not be equipped to manage this patient population. It is imperative to communicate this with the Operational Command that an ARSC team is not equipped or staffed for large scale patient decontamination that care timelines will extend during a CBRN event, and triage decisions may change significantly. See table below.

Table 1: CBRN Considerations for ARSC teams

CBRN Considerations for ARSC teams
• Develop hasty and deliberate decontamination plan (on arrival to a new site with all parties). • Conduct individual and team drills to practice donning personal protective equipment (PPE). • May use Nitrile gloves x 3 for protection– change outer glove if it becomes sticky or gummy. • Identify the nearest resource that has CBRN detection capabilities. • Identify large water source (55 gal drum or similar with hose). • Ample supply of rapid skin decontamination lotion. • Do not bring casualty into clinical facility until decontamination is complete. This is an element of proper triage. Anticipate loss of supplies and equipment used on patients prior to decontamination, and plan accordingly. • See JTS CBRN Injury Part I: Initial Response to CBRN Agents CPG [75].

BLOOD USE IN THE ARSC ENVIRONMENT

Blood is a resource that cannot be improvised and must be communicated to operational leadership as a mission critical requirement. Logistical factors with the ARSC team has to be considered even more so than at the Role 2 or Role 3. ARSC teams do not have dedicated personnel to manage the blood supply, storage, temperature regulation, accounting and resupply. Blood supply and resupply must be considered early and often. This is often managed through medical operations channels and requires close coordination with the combatant command blood program and regional blood logistic process. Maintaining stored blood products within a narrow temperature range and subsequently warming them in a timely manner are two of the greatest challenges of austere trauma medicine.[13,50] In an unstable and critically ill combat casualty, early balanced blood resuscitation (ideally whole blood) has been clearly shown to improve 72-hour mortality.[4,13,76-79] ARSC teams must anticipate blood requirements, work with the theater blood program manager to meet those requirements, plan for their own walking blood bank, and prepare for contingencies.[13,58]

Fresh Whole Blood (FWB) use in the combat casualty setting is associated with improved survival when compared to administration of packed red blood cells (PRBCs) and fresh frozen plasma (FFP) alone.[80] FWB eliminates the need for blood cooling, storage, and rewarming equipment, but carries increased risk of transmissible disease, and FWB donors may be limited in some operational environments. It is recommended, and will be doctrinal in an upcoming DoD Instruction, that anti-A and anti-B titer levels be drawn on all deploying personnel with type O blood in addition to FDA recommended infectious disease testing. This strategy provides a constant blood donor pool for contingencies. For U.S. casualties, FWB donors should be U.S. personnel, rarely from coalition, and from local nationals only in the most extreme cases. See the JTS Whole Blood Transfusion CPG, 15 May 2018 for detailed guidance.[81] Point of care testing for some transmittable diseases exist (e.g., human immunodeficiency virus), but the required time for interpretation may be prohibitive in patients in severe hemorrhagic shock. Have a plan in place for patients and donors who test positive for such diseases, and recognize that there may be significant cultural implications with local nationals and partner nation forces who test positive for such diseases.

The need to remain light and mobile further increases the challenge of retaining an adequate supply of blood products for mission support.[50] Portable battery-operated blood refrigerators and freezers are available (e.g. HemaCool®) but require mobility platforms to move over long distances and mechanical failures in hot and dusty environments may occur. Refrigerators and freezers require a constant and reliable power source, further increasing the team's weight and footprint and reducing maneuverability. Mission requirements for increased mobility may limit the size and number of refrigeration equipment and thus blood availability,[13] and vice versa.

RBC and frozen plasma are readily available at Role 2, Role 3 and at ARSC teams, but supply of platelet components are limited despite increasing use of cold stored platelets. Stored LTOWB and never-frozen liquid plasma are increasingly available via the ASBP theater blood distribution system. Freeze-Dried Plasma may be available for some ARSC missions supporting SOF. Options for acquiring blood outside official supply and resupply channels include walking blood bank drives (requires blood typing capability such as Eldon cards as well as citrate bags) and blood from the local "economy" such as local hospitals for use on host nation casualties should be considered when appropriate. Inform the theater JBPO if considering local host nation supply of blood products.

BLOOD WARMING

Conventional warming techniques for blood transfusion such as the Belmont® Rapid Infuser or plasma thawing devices draw significant power requirements and may be unavailable in the austere setting. Battery operated, in-line products are easily packed, however flow rates are inversely proportional to infusion temperature and may be inadequate for the trauma patient in severe hemorrhagic shock. Plasma thawing devices may be available in some equipment sets, but may not be suitable for small/highly mobile surgical teams or in the ARSC environment. There is no light, portable, approved plasma-thawing device. Portable water heaters and thermometers can be used to create a 30-37oC bath of water to thaw FFP and warm PRBCs to the appropriate temperature of 37oC; however, they are not FDA approved for this use. Approximately 10 percent of FFP bags may break during thawing and this should be factored into the supply. Pre-thawing frozen plasma saves time in the acute setting but once thawed, plasma must be used within 5 days.

WALKING BLOOD BANK

Every ARSC team member must be trained to draw and transfuse fresh whole blood, and must be able to recognize and manage transfusion reactions. Recruitment and blood typing of potential blood donors may take time, so early initiation of walking blood bank is recommended for patients with the suspected need for massive transfusion. Fresh whole blood transfusion must be type-specific, unless the donor has been pre-designated low-titer type O by laboratory testing. All low-titer type O donors must provide documentation of titer-testing prior to donation. See the JTS Whole Blood Transfusion CPG, 15 May 2018.[81] Standard equipment sets should contain blood drawing kits. Ensure that Eldon cards and point-of-care infectious disease testing kits are available and team members are trained on their use. Ensure a reliable system for marking and numbering: 1) individual donors, 2) blood donor bags, and 3) Eldon cards.

LOGISTICAL CONSIDERATIONS

Packing for ARSC missions can be framed usefully by the Ruck-Truck-House model developed by SOF medics,[82] which is a modular approach to mission planning based on cube and weight constraints. As building blocks, each phase of this supply model builds upon itself, with Ruck capabilities intrinsic to Truck, and Truck capabilities intrinsic to House. The term Ruck-Truck-House refers to the cube and weight of the mission equipment and not

necessarily to the mobility platform. For example, 'Ruck' missions may be performed from a truck, and 'Truck' missions are often conducted via rotary wing platforms.

Specific team member composition of each team is based on multiple variables, and specific staffing recommendations are outside the scope of this practice guideline. Generally, ARSC teams should be prepared to scale their team size according to mission requirements dictated by the Operational Command. A Ruck team may be the smallest number of personnel of any given ARSC team that still provides a minimal, functional capability, while a House team may be the maximum number of personnel with maximal capability. Limitations of scaled teams must be clearly articulated to the Operational Command in order to accurately communicate inherent risk.

RUCK

The Ruck model is the most mobile pack out, as supplies and equipment are limited to what can be carried on each team member's back. It is well understood, that this is not the ideal environment for surgical care; however, mission requirements occasionally dictate this capability. When it comes to surgical intervention, or no intervention and likely casualty death, this substandard option becomes a mission requirement. Due to its inherent limitations on resources, the Ruck model requires the highest levels of clinical skill, tactical proficiency, and teamwork, and personnel must be highly trained in all above areas for mission success. Medical planners and the surgeon must clearly communicate the clinical and other limitations to mission planners and the supported Operational Command in order to conduct appropriate risk mitigation. The Ruck model fits onto most transportation platforms. Although emergency surgery may be performed with this model, it is generally capable of providing temporary support for only one critical patient with no capacity to hold critically ill patients for any length of time. Blood products are extremely limited and the lack of power and electricity prevents use of blood storage and cooling, blood warming, and electronic patient warming devices. As a result of these limitations, rapid patient evacuation to the next level of care is vital and urgent resupply must occur in order to continue the mission. Alternatively, the plan may include performance of en route care and return to base upon mission completion. Additionally, communications are limited to personal radios and team security must be provided by the supported unit during clinical care.

TRUCK

The Truck model is also very mobile, capable of set up or collapse within minutes, and can be transported to a fixed location. Although this model may have greater capability than the Ruck model, its limitations must be carefully considered and communicated to planners and commanders in order not to fail expectations placed upon it. It includes each team members' ruck and as many additional supplies and equipment that can fit onto the mission's mobility platforms, depending on the mission need. This model may be able to treat and sustain more patients but is also limited by power and electricity, blood storage, and fluid volume. Although supplies are increased, it is still dependent upon a rapid evacuation and resupply chain if heavy casualties are encountered or it is intended to perform a static mission.

HOUSE

The House model is far less mobile, as it refers to a fixed location where the full equipment loadout of an ARSC team can be established and is only feasible to be maintained at a team house, firebase, or other mission support site. This model provides the highest level of care organic to the team and has a greater patient capacity. Continuous operations may be sustainable with casualty evacuation and resupply of blood and other Class VIII. Additional requirements for full operational capability include power and electricity for blood cooling

and storage, blood warming and infusion, patient warming, water for steam sterilization and hygiene, and other requirements. Open communication of requirements, capabilities and limitations to planners and commanders will enable mission success.

In all three models, challenges are magnified with supply and resupply limitations, blood availability, and prolonged hold time, transport time to next level of care, personnel available to help, and more. It is understood that this is not the ideal environment to care for surgical patients and that certain severe injuries will not be survivable. As emphasized above, the limited capabilities of these teams have to be understood by mission planners and operational commanders. Clinical experts including the senior surgeon should be involved in medical planning of mission support in order to ensure that critical supply requirements and limitations are addressed, clearly articulated, and solutions are developed within mission constraints. Involve planners and the Operational Command early and often in mission planning to understand command requirements, mitigate risks, and shape expectations for success. See Appendix A for sample packing lists for each model.

Many mission variables impact what is ultimately packed into the finite cube and weight requirements for each model. See Table 2 below for some of the variables to consider when planning for logistical support of ARSC missions.

Table 2: Variables to consider when planning logistical support for ARSC missions

Variables to consider when planning logistical support for ARSC missions	
ARSC team composition	• Number and type of medical personnel on the ARSC team • Team members' specialties, experiences, capabilities, preferences
Patient variables	• Types of patients (friendly combatants, enemy, civilian, pediatric, geriatric, MWDs)
Mission	• Operational Command intent • Security situation (i.e. expected tactical risk to medical personnel) • Length of mission • Number of expected casualties, number of troops at risk • Communication capabilities of medics and next levels of care • Space available for equipment • Max/min equipment weight requirements • Security element for the ARSC team • Task force composition (joint, combined) and service, state or national caveats • Team sustainment requirements
Evacuation	• Capability, time, distance from forward medics • Capability of the evacuation platform (CASEVAC vs MEDEVAC vs CCATT) • Capability, time, distance to next level of care

Variables to consider when planning logistical support for ARSC missions	
Environmental	• AO-specific medical concerns • Night vs day operations • Cold vs hot environments • Indoors vs outdoors • Physical and human terrain • Security environment
Resupply	• Emergent and routine time and processes for resupply of blood products and Class VIII

RESUPPLY

Resupply should be categorized as Mission Critical, Mission Essential, and Mission Enhancing for planning and communicating purposes. The category of medical supply or equipment items may change depending on the mission.

- **Mission Critical**: There is high risk of mission failure without these items.
- **Mission Essential**: There may still be significant impact but less risk of mission failure if lacking these items.
- **Mission Enhancing**: There is low risk of mission failure if lacking these items.

The following subsets may require separate and deliberate logistical planning.

- **Mission Critical, consumable**: there simply are not ways to improvise shortfalls on a few things (i.e. blood products, citrate bags, IV calcium, key anesthetic medications)
- **Mission Critical, durable with lifespan**: replacement instruments, litters, replacement medical electronics such as ventilators, monitors, ultrasound, Doppler probe, suction, etc.

Frequent high use. May be improvised: laparotomy sponges, TCCC equipment, OR towels and drapes, dressings, flushes, syringes, IV catheters, IV tubing, HPMKs, suture, lines, tubes, pain medications, antibiotics, etc.

A best practice is to plan with the supported unit's logistical support personnel in order to increase available assets for resupply and shorten the time required to execute. Educate the supported unit on movement requirements and limitations of critical supplies in order to facilitate timely and accurate decisions if a medical representative is not available at the higher level of command. Establish push and pull rapid resupply packages, often called "speed balls," at the resupply base with focus on medications and expendables rather than durable equipment. Establish and practice supporting procedures in order for resupply to function well, and maintain abundant medical supply stocks for unexpected requirements. Depending on the mission, consider incorporating non-U.S. resupply resources into medical logistics planning including intergovernmental organizations, non-governmental organizations, and host nation facilities and services. Such schemes may optimize coalition or advise, assist, and accompany missions where the population at risk may be primarily host or foreign country nationals.

SPECIFIC LOGISTICAL CONCERNS

Surgical Sets

Traditional Role 2 surgical sets are bulky, difficult to access, and redundant.[3,83] Surgeons and surgical technologists should work together to design sets that support their specific mission. In general, hold and evacuation times are directly proportional to the degree of care to be rendered, and subsequently, the amount of equipment required. See Appendix A for packing considerations organized by the Ruck-Truck-House model.

Anesthesia Equipment

Equipment should be mobile and adaptable to a variety of surgical cases. TIVA and regional anesthetic strategies are mobile and light. Additionally, regional anesthetics will decrease requirements for systemic pain medication and lessen the concern for airway compromise and management. The use of regional anesthesia in patients at risk for compartment syndrome is controversial; although the data is sparse, there is no evidence that peripheral nerve blocks delay the diagnosis.[84]

Nursing Equipment

Nursing equipment is often single use, disposable and requires frequent resupply (i.e. IV catheters, IV tubing, syringes). Careful reuse of nursing items for the same patient will minimize waste. Long term nursing supplies are not necessary since the ARSC teams do not have holding capacity and rely heavily on expeditious transport to the next level of care.

Instrument Sterilization

There are three principal methods to sterilize instruments including autoclave or steam sterilization, exposure to dry heat, and chemical antiseptics. Boiling is regarded as unreliable.[85] Mechanical or steam sterilizing devices are large, require high power input, and require several hours to clean, dry, and cool instruments. If sterilization devices are not available on site, instrument sets may be autoclaved or steam sterilized at a base of operations and turned over between missions. Careful planning should be used in packaging instrument sets so that not all instruments are opened and contaminated at once.[83] The minimum standard for instrument decontamination is application of enzymatic cleaner followed by disinfection with an antiseptic, which can be achieved with a number of solutions including formaldehyde, glutaraldehyde (Cidex®), or chlorhexidine. Refer to the manufacturer's standards for time of solution contact and other considerations. In order to preserve resources, certain disposable items such as surgical staplers, clip appliers, or cautery pencils may be disinfected in chemical solution. Cautery grounding pads may be cleaned and reused with germidical wipes; while not ideal, this is the reality of the ARSC environment.

Power Requirements

The medical team must communicate power requirements to the supported element. Medical electronics and blood storage require power. Planning considerations include the size of the generator, voltage output (i.e. 110V vs 220V), maximum ampere load, optimal and maximum wattage operating ranges, type of fuel used, amount of fuel required for the mission, and maintenance plans. Other considerations include the total power required for all electrical equipment, the daily fuel consumption, and the capacity in amperes of the largest available circuit breaker needed to power a heating element or other high energy device. 110V vs 220V power outputs and devices must be carefully matched to provide adequate power to medical equipment and prevent destruction of critical electronic equipment. Be careful to maintain an ample supply of fuses for important electronic equipment. Note that each piece of equipment has unique and specific fuses that are not universal to each

other and are prohibitively difficult to find on the local economy in most deployed locations. See Table 3 below for mission critical tasks and equipment that require power.

Medical Waste Disposal

Field hospital medical waste has been estimated to be an average of 1.5 to 3 kg of waste per patient per day.[86] ARSC planners should anticipate considerably more waste in the ARSC setting given the critical nature of patients with wartime injuries. Team members should be sensitive to local religious customs when disposing of anatomic waste.[86] The World Health Organization (WHO) recommends appropriate disposal of potentially infectious biological waste by either steam sterilization or high temperature incineration.[85] Burying waste is an option but consideration should be given to avoid pollution of the environment and water sources.[85-86] Establish a safe system to dispose of sharps. The International Committee of Red Cross Manual of Medical Waste Management is an excellent resource and provides specific guidance.[86]

Table 3: Mission critical tasks and equipment that may require power

Mission critical tasks and equipment that may require power		
Ruck—	Patient warming	HPMK, ready heats, wool or space blankets
	Blood cooling	Person-portable preconditioned coolers
	Blood warming	Small battery powered in-line products
	Medical electronics	Battery powered portable ventilator, monitors, and ultrasound
	Electrical power	Plan for person-portable, battery operated equipment
	Lights	Battery operated head lamps (consider equipment that uses standard batteries such as C123, AA, AAA etc. as opposed to nonstandard rechargeable lithium batteries as replacement batteries are more easily acquired)
	Communications	Battery powered radios
	Personal electronics	Minimal battery power only
Truck –	Patient warming	HPMK, ready heats, wool or space blankets
	Blood cooling	Coolers with wet ice for blood or dry ice for plasma, battery powered man portable blood fridges (e.g., HemaCool®)
	Blood warming	Recommend Belmont® Rapid Infuser or plasma thawing devices if power capability allows; if unable to support Belmont, utilize in-line device.
	Medical electronics (monitors)	Battery power with recharging cords – stress 110V vs 220V awareness
	Electrical power	Plan for Generator size 5kW-20kW and associated fuel requirement
	Lights	Battery operated head lamps, person-portable free-standing LED spot lights
	Communications	Vehicle mounted radio
	Personal electronics	Minimal rechargeable
House –	Patient warming	HPMK, ready heats, wool blankets, Bair hugger, consider wall space/area heating units with understanding that these have tremendous power requirement
	Blood cooling	Multiple battery powered portable blood fridges (e.g., HemaCool®), ensure backup power source is available should primary power source fail.

Mission critical tasks and equipment that may require power		
	Blood warming	Recommend Belmont® Rapid Infuser or plasma thawing devices if power capability allows; if unable to support Belmont, utilize in-line device.
	Medical electronics (monitors)	In line power, stress 110v vs 220v awareness
	Electrical power	Central power vs large generator
	Lights	Battery operated head lamps, person-portable free-standing spot lights, wall mounted lights
	Communications	Non-classified Internet Protocol (IP) Router Network / Secret Internet Protocol Router Network / WiFi (choice)
	Personal electronics	Choice

DOCUMENTATION

Accurate, and complete documentation promotes patient safety, and facilitates patient transfer, handover, and continuity of care. Documentation is required at all levels of care and can be challenging. In the ARSC environment, documentation is essential not just as part of a clinical standard but secondary to the need to further define, refine, and understand the limitations of this battlefield capability. The relatively low volume of causalities these teams have managed combined with the paucity of documentation received for Performance Improvement analysis makes understand the true capability and capacity of ARSC teams a challenge. Additionally, appropriate and reliable analysis requires accurate and complete data, which will then, allow more appropriate medical planning. In some cases, documentation and transmission is challenging due to a lack of communication equipment that enables reliable communications with higher levels of medical care. The ARSC environment is resource and personnel limited, and time must be committed to complete documentation on all patients. Experience has shown that in the setting of a MASCAL (when taking time to document seems the most challenging), proper documentation aids with communication, decreases redundant evaluations, avoids errors, and ensures complete care. Consider language barriers with documentation. In unconventional warfare and depending on the unit the ARSC team is supporting, using patient identifiers may not be permitted. If caring for host national casualties, using non U.S. forms in their native language may be beneficial medically and practically.

The JTS MASCAL/Austere Trauma Resuscitation Record and an operative note and anesthesia record for surgical patients is the minimum required documentation for all patients. Minimum documentation includes mechanism of injury, injuries identified, signs and symptoms, and treatments, vital signs, neurologic status, medications, and interventions provided. Follow the Combatant Command or regional standard naming convention for trauma pseudo names and maintain one consistent name for each patient during transfers. This improves continuity of care, patient tracking, blood resupply, and outcome analysis. In the operational setting include ethnicity, unit affiliation, and geographic location of injury as able. Use the JTS Burn Resuscitation Flow Sheet for major burns and prolonged field care flow sheet for prolonged care. When evacuating to higher level of care, records should be transferred with the patient. A photograph or copy of the record should be kept by the surgical team in the event the record is lost. When documentation cannot be completed prior to patient evacuation, complete the documentation immediately after evacuation and send it electronically to the next level of care as soon as able. Submit patient records to the DoD Trauma Registry (DoDTR) via dha.jbsa.healthcare-ops.list.jts-trauma-registry@health.mil or to the closest Role 3 or 4 medical treatment facility patient administration as soon as able. Keep a log of all trauma patients and submit to the DoDTR.

PERFORMANCE IMPROVEMENT (PI) MONITORING

Patient population: All patients treated by ARSC team

INTENT (EXPECTED OUTCOMES)

- ARSC teams will receive ARSC-specific, team-centric pre-deployment readiness training to include medical aspects and operational aspects of ARSC.
- Documentation is completed for all patients treated by ARSC teams (e.g., using the JTS Austere Trauma Resuscitation Record and an operative note) and submitted to the JTS or uploaded into the TMDS.
- Ultrasound of the chest and abdomen is performed and documented for patients with penetrating trauma to chest, abdomen, or pelvis or severe blunt trauma in order to rule out life threats.

PERFORMANCE ADHERENCE MEASURES

- All ARSC teams receive ARSC-specific training through a designated course or unit-specific training.
- Documentation is received by the next role of care and JTS for all patients treated by ARSC teams to include:
- Trauma Resuscitation Record
- Operative note if applicable
- Anesthesia Record if applicable
- An ultrasound of chest and abdomen is documented for all patients with penetrating trauma to chest, abdomen, or pelvis (gunshot wound or blast) or severe blunt trauma.
- Tourniquet times are documented (placement and removal times).
- All tourniquets are removed and bleeding controlled prior to transfer from a surgical capability.

DATA SOURCES

- Patient Record
- DoDTR

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ARSC EQUIPMENT CONSIDERATIONS

The following equipment lists are not complete packing lists. Teams should pack according to mission requirements, with expected numbers and types of patients significantly impacting quantities of medications and supplies.

For specific surgical instrument recommendations, please refer to: Hale DF, Sexton JC, Benavides LC, Benavides JM, Lundy JB. Surgical Instrument Sets for Special Operations Expeditionary Surgical Teams. J Spec Oper Med. Fall 2017;17(3):40-45. https://www.jsomonline.org/JournalArticles/20173.php#Article708

Disclosure: This CPG, the U.S. Air Force, U.S. Army, U.S. Navy, and DoD does not endorse or promote any specific products.

Ruck model—Plan for 1-2 surgical patients with 80% of combat trauma injury patterns	
TCCC equipment	• Litter • Tourniquets • Dressings, splints (e.g. Combat Gauze®, ACE, medical tape, Coban™, Kerlix™) • Needle Decompression catheters • Airway equipment (e.g. oropharyngeal airways, nasopharyngeal airways, definitive airways, AMBU bag, etc.) • Muzzle and large ETTs for MWD use
Nursing equipment	• Personal Protective Equipment • IV start kits, IO devices, extension tubing, Blood tubing • Syringes/flushes • IV fluids • Assorted lines/tubes/drains • Walking Blood Bank supplies (citrate bags, Eldon cards)
Airway and anesthesia equipment	• Airway instrumentation • Ventilation equipment • Regional anesthetic block needles • Dial-a-flow (infusion set) • Centurion pressure transducer • Non-elastic bougie
Medications	• Tranexamic acid • IV Calcium • Anesthetics • IV and PO Analgesics • IV and PO Antibiotics • ACLS medications • Antiepileptics • IV Fluids (including hypertonic saline for TBI) • Assorted ‘sick call’ meds

Ruck model—Plan for 1-2 surgical patients with 80% of combat trauma injury patterns (continued)	
Surgical instruments	• Major Instrument Set • Chest set with rib-spreader and Lebsche knife • Limited Vascular set – a few fine instruments and vascular clamps • Orthopedic bone saw (Gigli wires are intended to be single use, are fragile, and are difficult to re-sterilize)
Suture material	• Absorbable suture, given high likelihood of contaminated wounds • Heavy PDS for fascia • Fine Prolene for vascular repair • Fine PDS for urologic and airway repairs • Absorbable free ties for ligation of small vessels • Heavy silk to secure tubes/drains • Umbilical tape • Heavy chromic for hepatic repairs • Bone wax for amputations • Vessel loops, large and small • Pledgets
Other surgical equipment	• Head Lamps • Cricothyroidotomy Kit • GIA Staplers with reloads • Topical Hemostatic Agents • Surgical Sponges (Ample supply of sponges cannot be overstated or overemphasized) • Vascular Shunts • REBOA catheter and introducer kit • Chest Tubes, chest seals, and Heimlich valves • Skin staplers • Temporary Abdominal Closure device (e.g., Ioban)
Electronics	• Portable, battery powered ETCO2 monitor • Video laryngoscope (GlideScope®) • Portable, battery powered pulse ox monitor • Portable, battery powered vital signs monitor • Blood cooling container (e.g., golden hour box) • Hand-held Doppler device • Hand-held ultrasound device • Portable ventilator • In-line IVF/blood warming device • Clippers for MWD use

Operational equipment	• Internal and external communication equipment (e.g., hand-held encrypted radios, Peltors) • Eye protection, ear protection • Night vision equipment • Headlamp capable of red/green/blue light • Navigation tool(s) (e.g., lenzatic compass, GPS) • Survival equipment (e.g., blood chit, escape and evasion kit) • Tactical protective equipment (body armor), IFAK • Personal weapons and ammunition

Truck model—Pack for 2-5 surgical patients with 80% of injury patterns. Includes increased quantities of all Ruck items.	
Added TCCC equipment	• Litters • MASCAL kit • CBRNE kit
Added anesthetic equipment	• Oxygen • OG tubes • RIC catheters
Added surgical instruments	• Consider 2 or more of each instrument set • Limited external fixator set
Other surgical equipment	• Operating Table/Litter Stands + Arm Boards • Broselow bag
Added electronics	• Point of care laboratory testing (iSTAT requires regular maintenance including calibration and cartridges must be temperature controlled) • Battery-powered blood fridges and/or freezers • Belmont Rapid Infuser
Added operational equipment	• Person-portable generator to power electronics with maintenance kit • Space heater • Fuel for generator • Tentage to set up patient care space

House model—This model may allow for true surgical sets. The number of sets required will depend on how many simultaneous OR tables the site is intended to provide. Consider frequency and time required to re-sterilize instruments. Includes increased quantities of all Truck items.	
Anesthetic equipment	• MAC catheters
Medications	• Increased IV Fluids
Surgical instruments	• Consider several of each instrument set above • Craniotomy set • Several external fixator sets • Surgical suction and tubing • Surgical energy device (e.g., Bovie)
Other surgical equipment	• Consider larger capacity blood refrigeration equipment • Litters • More than 1 OR Table/Litter Stands + Arm Boards • Overhead Free-standing Lighting • Plasma thawer or Belmont Rapid Infuser • Instrument sterilizer • More robust MASCAL kit • Additional litters
Electronics	• Arterial line pressure monitoring equipment
Operational equipment	• Larger generator(s) with required fuel, wiring, circuit panels • Multiple space heaters • Wall mounted lighting

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Blunt Abdominal Trauma, Splenectomy, and Post-Splenectomy Vaccination (CPG ID:09)

To provide guidance on the management of combat casualties who sustain blunt abdominal trauma.

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BACKGROUND

Unlike penetrating abdominal injuries where the decision to operate is relatively straight forward, those combat casualties that sustain Blunt Abdominal Trauma (BAT) offer more of a diagnostic and clinical challenge. With the improvements in body armor, truncal injury has decreased despite increasingly more lethal weapon systems. With the advent of Improvised Explosive Devices (IEDs), however, more casualties are presenting with evidence of BAT. While Computed Tomography (CT) scans are available to assist the provider in decision making at a Role 3 facility, providers at far forward surgical units must decide to operate based on a physical and a focused assessment with sonography for trauma (FAST) exam.[1]

It is incumbent on the senior surgeon at each facility to ensure the staff understands their resource limitations and the inherent limitations associated with the use of the FAST exam to diagnose a hemoperitoneum. For hemodynamically unstable trauma patients with a positive FAST, exploratory laparotomy should be undertaken immediately. Rarely, patients with a positive FAST and/or CT scan may be managed non-operatively if they are already at a Role 3 facility that can ensure adequate clinical follow-up and evaluation. Patients who have a positive FAST exam and/or evidence of hemoperitoneum through CT at a surgical facility should not be transferred until any and all ongoing intra-abdominal hemorrhage is completely assessed and controlled. The benefits of non-operative management do not outweigh the risks of an in-flight hemorrhagic emergency with no potential for therapeutic surgical intervention. Patients who evolve peritonitis by physical exam or continue to consume blood products in order to maintain blood pressure warrant exploratory laparotomy. An algorithmic approach to the blunt trauma patient is presented in Appendix A.

Splenic injury grading is presented in Table 1 below. All grade IV-V splenic injuries should undergo splenectomy due to the high risk of failure of non-operative management with or without splenic embolization[2] and the need for prolonged transportation out of theater. Lacerated spleens of any grade with active hemorrhage encountered during laparotomy for any reason are best managed by splenectomy. If the tactical situation permits stable grade III splenic injuries without active extravasation, pseudo aneurysm, hemoperitoneum on CT scan or other indications for laparotomy that may include, but are not limited to associated injury may undergo attempt of non-operative management under the direct supervision of an experienced trauma surgeon.[3] Ideally, patients undergoing attempted splenic salvage should be monitored in the Role 3 facility for at least 48 hours prior to strategic evacuation out of theater. In Role 3 facilities with interventional radiology capabilities, embolization of grade III splenic injuries may be considered as an adjunct to non-operative management. Embolization is not definitive treatment for splenic injuries so these patients must also be monitored for 48 hours following the procedure and prior to strategic aeromedical evacuation from theater.

Table 1. Organ Injury Scaling Spleen

Grade	Injury Description	AIS 90
I	Subcapsular Haematoma, <10% surface area Laceration Capsular tear, <1cm parenchymal depth	2 2
II	Subcapsular Haematoma, 10-50% surface area Intraparenchymal, <5cm diameter Laceration 1-3cm parenchymal depth not involving a parenchymal vessel	2 2
III	Subcapsular Haematoma, >50% surface area or expanding. Ruptured subcapsular or parenchymal haematoma. Intraparenchymal haematoma >5cm Laceration >3cm parenchymal depth or involving trabecular vessels	3 3
IV	Laceration of segmental or hilar vessels producing major devascularization (>25% of spleen)	4
IV	Laceration Completely shattered spleen Vascular Hilar Vascular Injury which devascularized spleen	5 5
	Advance one grade for multiple injuries to same organ up to Grade III.	

A contrast CT scan should be obtained at 48 hours (and before aeromedical evacuation out of the Role 3 to assess for complications such as pseudonaneurysm formation on all patients undergoing non-operative management of splenic injury.[4] Indicators of failure of non-operative management of the spleen include but are not limited to any need for blood transfusion and any hypotensive episode. For Grade I-III splenic injuries success rate of non-operative management with embolization reach 99-100%. Patients who fail non-operative management of the spleen require splenectomy at the Role 3 prior to aeromedical evacuation. It must be stressed that placing a patient in the aeromedical environment is akin to discharge from the facility ***without activity restriction*** and without the option of re-admission during the complete inter-facility transport between theaters which must be assumed to be a minimum of 12 hours. Additionally, the patient's history should be discussed between the referring and accepting surgeons prior to evacuation. Patients with Grade III splenic injury and Traumatic Brain Injury (TBI) should undergo splenectomy due to the fact that hypotension with TBI will double mortality.[5] Angiography and embolization for blunt injuries of other visceral organs may be used as an adjunctive procedure and should be determined on a case by case basis.

OVERWHELMING POSTSPLENECTOMY SEVERE INFECTION (OPSI)

In a review of post-splenectomy patients from 1966-96, with a median follow-up of 6.9 years, invasive infection occurred in 2.3% of trauma patients with a 49% mortality rate.[6] Patients present with nonspecific flu-like symptoms rapidly progressing to fulminant sepsis, consumptive coagulopathy, bacteremia, and untimely death within 12-48 hours. The infections are typically caused by encapsulated organisms including Streptococcus pneumoniae, Haemophilus Influenzae type B, and Neisseria meningitidis, for which there are effective vaccines. One study demonstrated that only 56.7% of patients receive all vaccines needed.[7] Since these patients are at risk for OPSI, there must be a standardized process to provide post-splenectomy vaccination, accurate documentation, and life-long tracking to identify outcomes.

VACCINE CANDIDATES

All splenectomized patients and those deemed to be functionally asplenic (e.g., <51% normal architecture and/or vascularization in the remaining splenic segment).

VACCINE DOSING

PNEUMOCOCCAL

1. Prevnar 13 (PCV13) AND Pneumovax 23 (PPSV23) are both recommended.[8]
2. Single dose of PCV13 should be given to patients who have not previous received PCV13.
3. PPSV23 should be given 8 weeks after PCV13 for those who have not previously received PPSV23.
4. One-time revaccination of PPSV23 should be administered 5 years after the first dose.

HAEMOPHILUS INFLUENZAE TYPE B (HIB)

Single dose of any Hib conjugate vaccine (PedvaxHIB, ActHIB, or Hiberix) is recommended for those who have not previously been vaccinated for Hib.[9]

MENINGOCOCCAL

1. Vaccination for serogroup B (MenB) as well as serogroups A, C, W, and Y (MenACWY) is recommended.[10,11,12]
2. For those not previously vaccinated for MenB, either Bexsero (2 dose series) or Trumenba (3 dose series) may be given.
3. For those not previously vaccinated for MenACWY, either Menveo or Menactra should be administered as a 2 dose primary series. After the primary series, a booster dose is recommended every 5 years.
4. For those that have been vaccinated for MenACWY within 5 years, no booster is needed. If vaccinated beyond 5 years, a booster dose should be administered.
5. If Menactra is the only MenACWY vaccine available and the patient also is recommended to get Prevnar 13, Menactra should be administered 4 weeks after Prevnar 13.

VACCINATION ADMINISTRATION TIME

All patients for Aeromedical Evacuation: Administer recommended vaccines in the immediate postoperative period at the first facility that can do so. See above for timing if patient is recommended for both Prevnar 13 and Menactra. Role 3 and Role 4 facilities should not assume that vaccination have occurred prior to arrival.

Host nation and other patients NOT evacuated out of theater: Administer recommended vaccines in the immediate postoperative period at the first available opportunity but no later than the 14th postoperative day.

Table 2. Guide for the Vaccine Naïve Patient

Guide for the Vaccine Naïve Patient (*If patient has previously received one or more of the listed vaccines, see text for guidance.*)				
Bacteria	**Vaccine**	**Dose and Timing***		
Streptococcus pneumoniae	Prevnar 13	Single Dose		
	Pneumovax 23	One dose ≥8 weeks after Prevnar 13	Second dose 5 years after first dose	
Nesseria meningitidis	Bexsero or Trumemba (serogroup B)	Dose #1	Dose #2 one month after first dose	If using Trumemba, Dose #3 five months after Dose #2
	Menactra or Menveo (serogroups A, C, W, and Y)	Dose #1 (if using Menactra, give 4 weeks after Prevnar 13®)	Dose #2 one month after first dose	Booster dose given every 5 year interval
Haemophilus influenza type b	PedvaxHIB **or** ActHIB **or** Hiberix	Single Dose		

**Vaccines should be administered as soon as the patient is clinically stable post-operatively*

VACCINATION DOCUMENTATION

A dated, timed, and signed physician order for recommended vaccines will be documented on the physician order form. If any recommended vaccines are not ordered, there must be clear documentation indicating the rationale for why one or more vaccines were not ordered. Doing so will facilitate clear communication along the continuum of care.

Vaccine administration documentation on the medication administration record (MAR) will include date, time, dose, lot number/lot sticker, manufacturer, and nurse signature for each vaccine. If any or all of the vaccines are ordered, but not administered (for any reason), the ordering physician must be notified, and there must be clear documentation indicating this and the rationale for why one/more vaccines were not administered. Also, document which provider was notified. This facilitates clear communication along the continuum of care.

Documentation in the electronic medical record for the physician order, dispensing from the pharmacy or immunization clinic, and nursing administration is preferred when possible. Documentation of vaccination is highly recommended in the service specific vaccination tracking systems (MEDPROS for Army, MRRS for Navy/Marine/Coast Guard, and ASIMS for Air Force) if available at the treating facility or operating base.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All trauma patients with blunt trauma injury type ***and*** any AIS-abdominal code.

INTENT (EXPECTED OUTCOMES)

1. Hemodynamically unstable (SBP < 90) blunt trauma patients with positive FAST undergo laparotomy (unless documented reason to delay/avoid).

2. All patients with grade IV and V splenic injuries requiring long-range evacuation undergo splenectomy or reason for non-operative management is documented.

3. Selective non-operative management of hemodynamically stable Grade I-III blunt splenic injury is performed at Role 2E, 3 or 4.

4. All patients who undergo splenectomy receive splenectomy vaccinations.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in population of interest with SBP <90 and positive FAST on arrival to a surgical capability who undergo exploratory laparotomy at the same level of care.

2. Number and percentage of patients with grade IV and V splenic injuries who undergo splenectomy.

3. Number and percentage of patients with each grade of splenic injury who are managed non-operatively.

4. Number and percentage of patients who undergo splenectomy who have documentation of pneumococcal and **HAEMOPHILUS** influenza vaccines.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Director, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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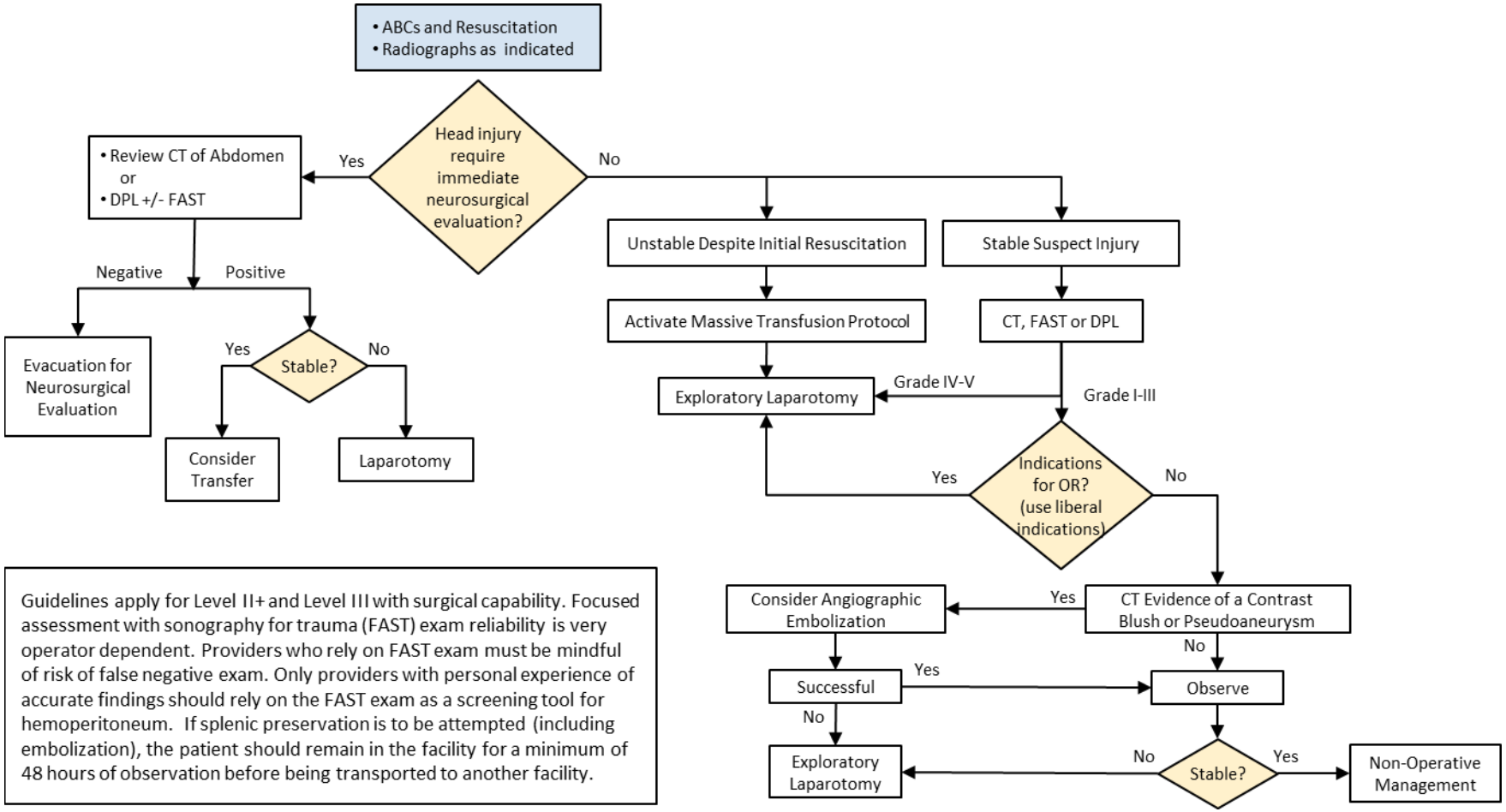
APPENDIX A: ALGORITHM FOR EVALUATING BLUNT ABDOMINAL TRAUMA



Guidelines apply for Level II+ and Level III with surgical capability. Focused assessment with sonography for trauma (FAST) exam reliability is very operator dependent. Providers who rely on FAST exam must be mindful of risk of false negative exam. Only providers with personal experience of accurate findings should rely on the FAST exam as a screening tool for hemoperitoneum. If splenic preservation is to be attempted (including embolization), the patient should remain in the facility for a minimum of 48 hours of observation before being transported to another facility.

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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (CPG)

Burn Care (CPG ID: 12)

Addresses burn injury assessment, resuscitation, wound care, and specific scenarios including chemical and electrical injuries. Reviews considerations for the definitive care of local national patients, including pediatric patients, who are unable to be evacuated from theater.

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07 Apr 2022 update: Isotonic fluid rate guidance

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INTRODUCTION

The goal of this CPG is to provide practical, evidence-based recommendations for optimal care of burn casualties in the deployed or austere setting who generally fall into one of two categories: military casualties who can be evacuated out of theater for definitive care and local national patients, often children, who are presented for care at military medical facilities with no possibility of definitive care beyond that provided in theater.

> ***NOTE:*** *If caring for a burn casualty, contact the U.S. Army Institute of Surgical Research (USAISR) Burn Center as soon as possible. Early consultation will facilitate coordination of care to include possible activation of the Burn Flight Team to assist with movement back to Continental U.S. (CONUS). Inability to contact the Burn Center should not delay the evacuation process. Contact the Joint Patient Movement Requirements Center (JPMRC) as soon as possible to coordinate aeromedical evacuation.*
>
> ***Burn Center***
>
> - *DSN 312-429-2876 (429-BURN)*
> - *Commercial (210) 916-2876 or (210) 222-2876*
> - *Email to usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil*

Optimal treatment of burn patients can consume enormous personnel and logistical resources. Despite the best efforts of providers at each level of care, the mortality for burn casualties who cannot be evacuated out of theater is significantly higher than that experienced in CONUS facilities. These and other factors must be considered in the deployed environment. Review of *Chapter 26: Burn Trauma in the 2013 Emergency War Surgery* manual is also recommended.[1]

POINT OF INJURY

1. In the field, ***INTERRUPT THE BURNING PROCESS*** and address any life threatening bleeding, airway compromise, or tension pneumothorax as directed by Tactical Combat Casualty Care guidelines. Burn casualties may have additional traumatic injuries which may be more life threatening and require immediate attention.

2. Address any life threatening bleeding, airway compromise, or tension pneumothorax per tactical combat casualty care guidelines.

3. Rinse off dirt and any contaminating chemicals, including hydrocarbon fuels, with clean water. Dry chemicals should be brushed off before irrigation. Once a survey of injuries is performed, cover the patient with blankets to prevent hypothermia.

4. Evacuate the casualty as soon as possible. Tactical considerations and distance may precipitate prolonged field care in which resuscitation is begun under pre-hospital conditions.

INITIAL BURN SURVEY

1. Perform primary and secondary surveys for any trauma patient. Acute injuries found in the primary and secondary survey should be addressed as per standard trauma protocols. Avoid becoming distracted by the appearance of burned tissues.

2. Assess and protect the airway, if needed. Immediate intubation may not be necessary in less severely burned casualties, thereby allowing time to complete the primary survey and prepare for controlled intubation.

3. Indications for endotracheal intubation include a comatose patient, symptomatic inhalation injury, deep facial burns, and burns over 40% Total Body Surface Area (TBSA).

NOTE: *Edema after burn injury causes most Supraglottic airway devices such as laryngeal mask airways (LMAs) to be inadequate.*

4. Use a large-bore endotracheal tube (ETT), especially if inhalation injury is suspected. Size 8 ETT or larger is preferred for adults. The larger ETT tube facilitates subsequent bronchoscopy and pulmonary toilet, and decreases the risk of later airway occlusion due to casts comprised of blood, mucus and debris.

5. Secure ETT with cotton umbilical ties which can be adjusted as edema develops during resuscitation; standard adhesive ETT holders do not work around burned skin. Consider securing ETT with stainless steel wire secured around a pre-molar tooth prior to long-range transport, particularly in patients with extensive facial burns. Frequently reassess position of the ETT during the acute resuscitation period as edema waxes and wanes.

6. Keep the patient warm. Burns increase insensible heat loss. Burn casualties with injuries >20% TBSA are at high risk of hypothermia.

NOTE: *Do not debride blisters until the patient has reached a facility with surgical capability. Cover burns with loose, dry gauze wraps or a clean sheet.*

ACUTE RESUSCITATION

1. Calculate the patient's initial burn size using the Rule of Nines (Appendix A). When wounds are cleaned, re-calculate using the Lund-Browder charts (Appendix B and Appendix C). Superficial (1st degree) burn is NOT included in the estimation of TBSA used for fluid resuscitation.

2. Superficial burns (1st degree) appear red, do not blister, and blanch readily. Partial thickness burns (2nd degree) are moist and sensate, blister, and blanch. Full thickness burns (3rd degree) appear leathery, dry, non-blanching, are insensate, and often contain thrombosed vessels.

3. If TBSA is 20% or greater, patients typically require acute fluid resuscitation for the next 24 to 48 hours with close observation until hour 72 post-burn.

4. Place a Foley catheter with calibrated urometer chamber. Burns to the penis are not a contraindication to urinary catheter placement. Suprapubic bladder catheter placement is rarely, if ever, required in burn patients and should be avoided in the presence of abdominal burns.

5. If available, for patients weighing 40 kg or more, use the Burn Navigator, a burn resuscitation decision support fluid calculator.[2] At the top of every hour, follow the prompts and enter the intake and urine output (UOP) values. The device will provide isotonic fluid rate recommendations for the next hour. For guidance, see the Burn Navigator Training and Resources.

6. The device uses feedback algorithms and the principles listed below to make fluid rate recommendations. The goal is to achieve an hourly target UOP of 30-50mL/hr.

7. Intake and output tables and graphs display how much fluid a patient received. Graph colors change as the patient approaches over-resuscitation danger zones of >200mL/kg and then >250mL/kg.

8. The system seeks to encourage communication between physicians and bedside nurse by displaying an assessment checklist, alert, and minimum and maximum rate recommendations.

9. Each Burn Navigator device allows resuscitation of only one patient at a time.

   CAUTION: *The Burn Navigator is NOT intended to be used for electrical burn injuries resulting in rhabdomyolysis with pigmenturia (red-brown urine). Resuscitation fluid needs in these patients often outpace the system's recommendations. Use clinical judgment and consider the entire scenario when interpreting recommendations, especially when patients have conditions that artificially alter UOP.*

10. For adults, if the Burn Navigator system is not available, initiate manual intravenous (IV) fluid resuscitation using the Rule of 10s (10 mL/hr x %TBSA)[3] Use the Burn Resuscitation Worksheet (Appendix D) [4] to assist initiation of fluid resuscitation.

11. For patients weighing more than 80 kg, add 100 mL/hr to IV fluid rate for each 10 kg >80 kg.

12. For children, 3 x TBSA x body weight in kg gives the volume for the first 24 hrs. One half is programmed for delivery during the first 8 hours. Further guidance for pediatric management is provided below.

13. Lactated Ringer's (LR), PlasmaLyte A (Baxter International, Deerfield, Il) or other isotonic solution is the preferred resuscitation fluid; other solutions (normal saline) should be used with caution as electrolyte imbalances may result. In the absence of overt hypotension (MAP <55), avoid fluid boluses as additional volume contributes to edema. Instead, increase the rate of IV fluids to maintain adequate organ perfusion, as reflected by urine output (UOP).[3]

14. The use of blood products in major burn resuscitation due to coagulopathy, anemia, and bleeding from escharotomy sites or other traumatic injuries is common. Refer to the Joint Trauma System Damage Control CPG for transfusion guidelines and resuscitation of patients with other significant injuries.

15. Monitor UOP closely and decrease or increase the isotonic fluid rate by approximately 20-25% per hour to maintain a UOP of 30-50 mL/hour in adults, or 0.5 to 1 ml/kg /hr in children. Every attempt should be made to minimize fluid administration while maintaining organ perfusion. If UOP> 50 mL/hr, then decrease the fluid rate by 20% for two consecutive hours and reassess. Increase rate of LR by 20% if UOP is less than 30 mL/hr (adults) or pediatric target UOP for 2 consecutive hours. Over-resuscitation can lead to many life threatening complications in the burn patient - so close monitoring of UOP and end organ perfusion is imperative.

16. Both under- and over-resuscitation can result in serious morbidity and even mortality; patients who receive over 250 mL/kg in the first 24 hours are at increased risk for severe complications including acute respiratory distress syndrome and both abdominal and extremity compartment syndromes.

17. Hour-to-hour fluid management is critical, particularly during the first 24 hours. Use the Burn Resuscitation Flow Sheet (Appendix D) to record both fluid intake and UOP.

18. At 8-12 hours post-burn, if the hourly IV fluid rate exceeds 1500 mL/hr or if the projected 24 hr total fluid volume approaches 250 mL/kg, initiate 5% albumin infusion using Table 1 (Adults only); for children, infuse 4-7 mL/kg at the rate of 0.5 mL per minute. Continue the 5% albumin infusion until the 48-hour mark. Fresh frozen plasma may be substituted. In children, consider colloid infusion at calculated maintenance rate, reducing the calculated isotonic infusion by at equal volume.

Table 1: Hourly infusion rates for 5% albumin for adults

5% Albumin Infusion (ml/hr)	30-49%TBSA	50-69% TBSA	70-100% TBSA
<70 kg	30	70	110
70-90 kg	40	80	140
>90 kg	50	90	160

19. If possible, measure bladder pressures every 4 hours in intubated patients with >20% TBSA burns.[5] Ensure the patient is in the supine position and follow the manufacturer's instructions for commercial kits; otherwise, use between 25 and 50 ml, being consistent in whatever volume is used, for serial measurements using a transducer located at the level of the symphysis pubis. Sustained bladder pressure >12 mmHg indicates early intra-abdominal hypertension and adjuncts such as colloid fluid should be considered. If the measured pressure is >20mmHg, the patient should be paralyzed and the measurement repeated. Persistent bladder pressures >20mmHg may indicate abdominal compartment syndrome (See Abdominal Compartment Syndrome below).

20. Combat casualties with burns often present with multi-system injury, to include inhalation injury, hemorrhage, and soft tissue trauma. Associated injuries may increase fluid needs above and beyond standard burn resuscitation formulas.

21. After approximately 24-72 hours, completion of resuscitation is marked by stabilizing hemodynamic parameters and reduction of IV fluid rate to a maintenance level. A well-resuscitated adult burn patient should follow commands, be hemodynamically stable, be tachycardic in the range of 110-130 beats per minute, and have UOP between 30-50 mL/hr. Acid-base balance should normalize, hematocrit should reveal a dilutional anemia, and pulses should be present in all extremities.

MANAGEMENT OF PERSISTENT OLIGURIA AND HYPOTENSION

Clinically significant hypotension must be correlated with UOP. Adequate end organ perfusion as estimated by UOP 30-50 mL/hr generally requires a MAP >55mm Hg. Persistent oliguria and hypotension should trigger an assessment of the patient's hemodynamic status and intravascular volume. Reassess for a possible missed injury or ongoing bleeding. Monitor intravascular fluid status using all available technologies. Consider early use of 5% albumin as discussed above as an adjunct.

When available, monitor central venous pressure (CVP); goal CVP is 6-8 mmHg. If CVP is low, increase IV fluid rate. If CVP is at goal but hypotension (Mean Arterial Pressure, MAP < 55mmHg) persists, use vasopressin 0.04 Units/min (do not titrate) followed by norepinephrine (titrate 2-20mcg/min) if needed. Epinephrine and phenylephrine may be used as additional vasopressors in severe shock proven to be non-hemorrhagic. If intravascular volume appears adequate (CVP at goal), STOP increasing IV fluid rate even if oliguria persists. Consider this patient hemodynamically optimized and that the oliguria likely results from an established renal insult. Expect and tolerate some degree of renal dysfunction in large burns. Continued increases in IV fluid administration, despite optimal hemodynamic parameters, will only result in "resuscitation morbidity," that is often times more detrimental than renal failure.

If the patient exhibits catecholamine-resistant shock, consider the following diagnoses:

- Missed injury and/or on-going blood loss.

- Acidemia. If pH < 7.20, adjust ventilator settings to target PCO2 30-35 mm Hg. If, despite optimal ventilation, patient still has a pH < 7.2, consider administration of sodium bicarbonate or THAM (tris-hydroxymethyl aminomethane).
- Adrenal insufficiency. If suspected start hydrocortisone 100 mg IV every 8 hours. Use of etomidate during rapid sequence intubation may increase risk of adrenal insufficiency.[6]
- Hypocalcemia. Consider empirically administering calcium chloride (8-16mg/kg IV) for refractory hypotension, especially in patients who have received a blood transfusion. If able to measure levels, maintain ionized calcium > 1.1 mmol/L.

SPECIAL CONSIDERATIONS

ANTIMICROBIAL PROPHYLAXIS

1. Prophylactic IV antibiotics are not indicated for burn injury in the absence of infection. Penetrating wounds or open fractures should be treated with antibiotics according to current guidelines. See Wound Care section for discussion of topical antimicrobials.

2. Administer tetanus prophylaxis as for any trauma patient.

3. If wound infection is diagnosed clinically, direct empiric therapy against gram positive and gram negative bacteria based on known geographic susceptibilities. If this data is unavailable, a good starting point is broad coverage with vancomycin for gram positive organisms and a carbapenem or 4th generation cephalosporin for gram negative organisms.

INHALATION INJURY

NOTE: *Refer to the JTS Inhalation Injury and Toxic Industrial Chemical Exposure CPG for additional information* [4]

1. Inhalation injury occurs secondary to smoke exposure and is exacerbated by retained carbonaceous particles (soot) and chemicals. Clinical signs include progressive voice changes, soot about the mouth and nares, hypoxia, and shortness of breath (See Initial Burn Survey for airway management recommendations). If available, use bronchoscopic lavage to remove debris. Be judicious, as excessive irrigation may transport irritants to uninjured lung. Serial bronchoscopy may be required to remove large debris or casts. Patients diagnosed with inhalation injury should receive aerosolized unfractionated heparin 5000 units per ETT every 4 hours; mix heparin with albuterol, as heparin can induce bronchospasm.

2. Populations at risk for carbon monoxide (CO) toxicity include those exposed in enclosed spaces to fires, engines, and cooking stoves. Symptoms of CO toxicity include confusion, stupor, coma, seizures, and cardiac ischemia. Administer 100% oxygen and measure CO-hemoglobin levels via co-oximetry if available. Hyperbaric oxygen therapy may further reduce the CO-hemoglobin half-life but this therapy is cumbersome and not available while deployed.

3. Cyanide is encountered in fires and industrial processes. Early effects include dizziness, headache, nausea, and anxiety. High dose exposure causes rapid onset of coma, seizure, respiratory depression, hypotension, and tachycardia. Lactic acidosis > 8 mmol/L is common. Administer 100% oxygen via mechanical ventilation. Hydroxocobalamin is the preferred antidote; infuse 5 grams IV over 7 minutes. It may be infused over 2-5 minutes in cases of cardiac arrest or severe hypotension, and may be repeated

if no clinical improvement.[4] Cyanokit™ should be available at every Role 3 hospital and Role 2 hospitals as well if there is a high risk of managing burn casualties.

4. Hydrogen fluoride (HF) is a byproduct of standard fire suppression systems. Exposure to HF may result in rapidly progressive or fatal respiratory failure despite minimal external evidence of injury. Symptoms include shortness of breath, cough, or hypoxia; there must be a high level of suspicion for HF inhalation.[9] Treatment is supportive. If hypocalcemia is present, administer nebulized calcium gluconate (1.5 ml of 10% calcium gluconate in 4.5 ml water) q4hr until normalization of serum calcium levels. In the absence of significant burns, consider steroids if symptoms do not improve. Bronchopneumonia can develop within a week.

OPHTHALMIC INJURY

NOTE: *Refer to the JTS Eye Trauma: Initial Care CPG for additional information.*[4]

1. Every patient with facial burns should have a thorough eye exam. If available, consult an ophthalmologist for all patients with facial burns or corneal injury verified by Wood's lamp exam. Eye exams should be done early, before facial edema sets in.

2. If no injury exists, lubricate the eyes of intubated patients every 2 hours with lacrilube.

3. If a corneal injury is identified, use a Fox shield to cover the eyes and apply ophthalmic erythromycin ointment at least every 2 hours.

4. If there is suspicion of an open globe injury, no drops or ointment should be applied, place a Fox eye shield and refer to an ophthalmologist as soon as possible. For further details, please refer to the Joint Trauma System Ocular Trauma CPG.[4]

LINES AND TUBES

1. Sew and/or staple all venous and arterial catheters in place as tape does not adhere to burned skin. Do not circumferentially tape lines around extremities; this may further impede circulation and cause limb ischemia as extremities swell during resuscitation.

2. Use umbilical ties to secure endotracheal, orogastric, nasogastric and Dobhoff tubes.

GASTROINTESTINAL PROPHYLAXIS

1. Burn patients, regardless of age, are prone to nausea and vomiting as well as stress ulceration.

2. Place orogastric or nasogastric tube in all intubated patients for gastric decompression during resuscitation and later for enteral nutrition.

3. Administer IV proton pump inhibitor or similar agent to all patients with >20% TBSA burn injury.

CIRCUMFERENTIAL BURNS, ESCHAROTOMY, AND EXTREMITY COMPARTMENT SYNDROME

1. Escharotomy is normally performed in the setting of a circumferential full thickness burn. If the burn is superficial or not circumferential and pulses are absent, first rule out hypovolemia, hypotension, or occult bleeding. Escharotomy incises the skin but not the fascia, and is usually sufficient for

compartment syndrome caused by burns unless there is underlying muscle damage or over resuscitation. Refer to the Escharotomy Chart in Appendix E.

2. The requirement for escharotomy or fasciotomy usually presents in the first 6-24 hours following injury. If the need for either procedure has not been identified within the first 24-48 hours, then circulation is likely to remain adequate without surgical intervention. Elevation of the burned extremities 30-45° is required to decrease edema. A patient who required escharotomy or fasciotomy at a lower echelon of care should always have their extremity compartments reassessed upon arrival at the next echelon of care. Extension of the incision(s) may be required to restore circulation. This situation can occur if large IV fluid volumes are given during transport, compounding tissue edema. The threshold for escharotomy should be low in patients requiring transportation, but must take into account the ability to transfuse the patient after the procedure.

3. For any circumferential extremity (including fingers) burn, hourly monitoring is essential. The extremity should be elevated as high as feasible, especially during transport. Palpable radial pulses do not exclude digital compartment syndrome and digital pulses must be checked by using the Doppler to assess the palmar arch and digital arteries for hand and digit burns. In general, palpable pulses of the radial, dorsalis pedis and posterior tibialis is sufficient as long as there are no burns distal to these pulses. Absent Doppler signals or pulses that are diminishing on hourly exams should prompt immediate consultation with a burn surgeon and strong consideration of surgical decompression with escharotomies.

4. Repeat the vascular exam at least every hour. If available, use handheld Doppler ultrasound to assess the palmar arch, dorsalis pedis, and posterior tibialis. A triphasic signal in the above vessels is considered normal. Consider performing escharotomy early, based upon the vascular exam. Consider fasciotomy in the operating room if pulses remain undetectable even after escharotomy. Continue hourly pulse checks to ensure adequate perfusion following surgical decompression.

5. Escharotomy is performed by incising full thickness burns into the subcutaneous fat. Patients will require analgesia, sedation, and usually intubation. Because escharotomy can be associated with significant blood loss, at times it may be more prudent to rapidly evacuate the patient to a higher echelon of care rather than initiate the procedure in an austere environment. This is a judgment call based upon assessment of local resources and transportation time and availability.

6. Using electrocautery to perform escharotomy reduces bleeding compared to a scalpel. Extend escharotomy incisions the entire length of the circumferential portion of full-thickness burn. The depth of the incision should be through the dermis to the level of subcutaneous fat; it is not necessary to carry the incision to the level of fascia. Carry incisions across involved joints. Although full thickness burn is insensate, patients will require IV narcotics and benzodiazepines during this procedure. On completion of the escharotomy, reassess perfusion. If circulation is restored, bleeding should be controlled with electrocautery and the extremity dressed and elevated at a 30-45° angle. Assess pulses hourly for at least 12-24 hours.

7. Thoracic escharotomy incisions should extend from the neck, across the mid-clavicle, and down the anterior axillary line. Connect each side with an incision across the upper abdomen.

8. In the upper extremities, place the hand in the anatomic position (palm facing forward) and make an incision in the mid radial or mid ulnar line, carrying the incision up the arm. Ulnar incisions should stay anterior (volar) of the elbow joint to avoid the ulnar nerve, which is superficial at the level of the elbow. If both hand and arm are burned, continue the incision across the mid ulnar or mid radial wrist and onto the hand. If circulation is not restored, perform a second incision on the opposite side of the extremity.

9. If finger escharotomies are required, avoid functional surfaces (radial surface of the index finger and ulnar surface of the little finger). Place the fingers in a clenched position and note the finger creases at DIP and PIP joints. Escharotomy incisions should be just dorsal to a line drawn between the tops of these creases.

10. Lower extremity escharotomy incisions are placed in the mid-lateral and/or mid-medial line extending from the ankle to the hip. If circulation is not restored, perform a second incision on the opposite side of the extremity.

11. If bilateral extremity escharotomy incisions do not restore circulation, re-evaluate the adequacy of the patient's overall hemodynamic status. Re-assess for a possible missed injury or ongoing bleeding.

12. Consider fasciotomy in the operating room (OR) if pulses remain undetectable after escharotomy. Continue hourly exams to ensure adequate perfusion following interventions. Optimal fluid resuscitation and prompt escharotomy usually mitigates the need for fasciotomy. Due to the frequency of extremity injuries seen among combat casualties, fasciotomies on burned extremities may be required for those with delayed revascularization, hemorrhage requiring massive resuscitation, and crush injuries. For further details, see the JTS Acute Extremity Compartment Syndrome and the Role of Fasciotomy in Extremity War Wounds CPG.[4]

13. High altitude aeromedical evacuation is not, in and of itself, a contributor to the development of compartment syndrome in a burned extremity. Escharotomy/fasciotomy for thermal burns should only be performed for the clinical diagnosis of compartment syndrome, and if available, confirmed by measurement of compartment pressures.

14. Following escharotomy or fasciotomy, late bleeding may occur as circulation is restored. Examine the surgical site every few minutes for up to 30 minutes for signs of new bleeding, which is usually easily controlled with electrocautery.

ABDOMINAL COMPARTMENT SYNDROME

Massive fluid replacement (> 250 mL/kg within 24 hours) is a risk factor for abdominal compartment syndrome, a clinical diagnosis which includes increased bladder pressure, increased airway pressures, oliguria, and hypotension.[7,8] Bladder pressure > 20 mm Hg in the setting of this syndrome warrants early consideration of therapeutic paracentesis which may provide partial relief of elevated intra-abdominal pressure related to sequestration of resuscitation fluid in burn patients.

The decision to pursue decompressive laparotomy must factor in the significant risk of morbidity and mortality from the procedure in patients with extensive burns or burns to the abdominal wall.[7] If the patient requires a decompressive laparotomy, perform a standard celiotomy followed by a temporary abdominal closure. If the abdominal wall skin is burned, adhesive drapes for negative pressure wound dressings (NPWD) will not adhere to the skin edges. Use of a Bogotá bag or similar sterile plastic material sewn to the skin edges is preferred.

CHEMICAL BURNS

NOTE: *Refer to the JTS Inhalation Injury and Toxic Industrial Chemical Exposure CPG for additional information*[4]

1. Expose body surfaces, brush off dry chemicals, and copiously irrigate with clean water. Large volume (>20L) serial irrigations may be needed to thoroughly cleanse the skin of residual agents. Do not attempt to neutralize any chemicals on the skin. Use personal protective equipment to minimize

exposure of medical personnel to chemical agents. Resuscitation strategy and goals for patients with chemical burns are the same as for thermal injuries.

2. White phosphorous fragments ignite when exposed to air. Clothing may contain white phosphorous residue and should be removed. Fragments embedded in the skin and soft tissue should be irrigated out if possible or kept covered with soaking wet saline dressings or hydrogels. Urgently retrieve deeply embedded fragments in the OR. Monitor calcium levels closely and treat hypocalcemia with IV replacement.

3. Contact the Army Burn Center DSN 312-429-2876 (BURN) or (210) 916-2876 or (210) 222-2876 or Email to usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil.

ELECTRICAL INJURY

1. First responders should remove the patient from the electricity source while avoiding injury themselves.

2. In cases of cardiac arrest due to arrhythmia after electrical injury, follow advanced cardiac life support (ACLS) protocol and provide hemodynamic monitoring if spontaneous circulation returns.

3. Small skin contact points (cutaneous burns) can hide extensive soft tissue damage. Observe the patient closely for clinical signs of compartment syndrome (refer to the Circumferential Burns section above, and the Extremity Compartment Syndrome CPG3 for discussion of escharotomy/fasciotomy). Tissue that is obviously necrotic must be surgically debrided. Note that escharotomy, which relieves the tourniquet effect of circumferential burns, will not necessarily relieve elevated muscle compartment pressure due to myonecrosis associated with electrical injury; therefore fasciotomy is usually required.

4. Compartment syndrome and muscle injury may lead to rhabdomyolysis, causing pigmenturia and renal injury. Pigmenturia typically presents as red-brown urine. In patients with pigmenturia, fluid resuscitation requirements are much higher than those predicted for a similar-sized thermal burn. Isotonic fluid infusion should be adjusted to maintain UOP 75-100 mL/hr in adult patients with pigmenturia. If the pigmenturia does not clear after several hours of resuscitation consider IV infusion of mannitol, 12.5 g per liter of lactated Ringer's solution, and/or sodium bicarbonate (150 mEq/L in D5W). These infusions may be given empirically; it is not necessary to monitor urinary pH. In patients receiving mannitol (an osmotic diuretic), close monitoring of intravascular status via CVP and other parameters is required.

WOUND CARE

Significant personnel and supply resources are required for wound care of major burns. Consideration should be given to rapidly transferring a patient to a higher echelon of care utilizing dry dressings and hypothermia protection at the Role 1 or Role 2 levels. Bear in mind that any dressings will likely be immediately removed upon arrival at the next echelon of care to facilitate patient evaluation.

Whenever possible, debride (remove sloughed skin and blisters) burn wounds in the operating room (OR), thereby providing a clean, warm environment to both examine the wounds and place sterile dressings. Use chlorhexidine gluconate or similar antiseptic cleanser. Debridement may be facilitated by scrub brushes and/or gauze sponges. Definitive removal of burn eschar (sharp/surgical excision) will be performed after stabilization and transport to the USAISR Burn Center.

1. Shave and debride the face, covering wounds with topical antibiotic ointment QID. Ear burns are prone to chondritis; apply mafenide acetate (Sulfamylon®) cream twice a day if available. Avoid pressure from endotracheal tube ties.

   If mafenide acetate (Sulfamylon) is not available prior to or during transport, thoroughly clean twice a day and utilize silver sulfadiazine cream or any other topical antimicrobial ointment. Examine frequently for cellulitis advancing beyond the ear or for evidence of necrosis of the cartilage. This requires surgical debridement.

2. Wrap burns on the scalp, trunk, neck, and extremities in sterile gauze soaked with a 5% solution of Sulfamylon. Apply the solution QID and as needed to keep dressings lightly moist, but not so wet as to cause maceration.

3. Alternatively, burns may be dressed with silver-impregnated nylon, covered with sterile gauze and moistened with sterile water. One of the advantages of this type of burn dressing is the ability to leave the dressing in place for extended periods of time (up to 7 days) which is advantageous during delayed or long-distance evacuations.

4. Avoid over-wetting dressings to avoid maceration of tissues. Frequent assessment of the patient's temperature is necessary to prevent hypothermia secondary to wet dressings, especially during air evacuation.

5. In patients who cannot be safely evacuated for burn excision, consider using silver sulfadiazine cream alternated BID with mafenide acetate (Sulfamylon) cream to provide antimicrobial penetration of thick burn eschar as a bridge to surgical care.

GUIDELINES FOR PATIENTS WHO CANNOT BE EVACUATED FROM THEATER

Care provided in theater is not envisioned to be definitive care. Definitive care for US service members is provided at the USAISR Burn Center in San Antonio, Texas. Coalition forces progress along the evacuation chain in order to return to their home nation health care facilities. Unfortunately, the care available to local national patients may fail to compare to the definitive care available for US and coalition forces. Care decisions are to be made in the context of the available continuum of care for the patient in their nations of origin.

1. Calculate burn size using a Lund and Browder chart (Appendix B and Appendix C.) Triage of local national casualties to an expectant category may be required if their burns exceed the host nation's ability to treat and rehabilitate (e.g. full thickness burns >50% TBSA). If caring for expectant casualties, provide adequate comfort care measures. Take into consideration inhalation injury, medical co-morbidities, and extremes of age, which can increase mortality.

2. For patients with combined partial and full thickness burns of 50% TBSA or greater, with less than half of the burn being full thickness, initiate resuscitation and allow the partial thickness component to declare itself as it is sometimes difficult to determine the full extent of the full thickness burn at the time of initial presentation. After approximately 48-72 hours, reassess the patient to estimate the percentage of full thickness burn more accurately.

3. Consider inhalation injury in relationship to the TBSA burned when deciding whether to classify the patient as expectant; a patient with a 40% TBSA burn and inhalation injury will likely not do as well as a patient with a 40% TBSA burn without inhalation injury.

4. Burn injuries may initially appear survivable, but skin graft loss, infections, or conversion of donor site(s) to full thickness wounds themselves may transform a potentially survivable injury into a fatal one. Be aware of this possibility and the potential change to an expectant category.

5. The transition from aggressive care to comfort care is a difficult decision, especially when the care team has worked exhaustively to maximize survival. The attending surgeon should elicit objective input from medical colleagues, nurses, and facility leadership in making the decision to transition to comfort care as it will solidify the process and assist with closure, especially for those engaged in the care of the patient for extended periods.

6. For patients with a less than 50% TBSA burn, proceed with resuscitation and plan for early excision and grafting within a week to maximize chance of survival.

7. Skin substitutes such as allograft (deceased donor skin) and biologic dressings such as xenograft (pig skin) are not readily available outside CONUS. The extent of burn excision should be guided by the amount of autograft (split thickness donor skin) available. Do not excise wounds if autograft is not available. Tangential excision should be employed, if possible, to preserve viable dermis and subcutaneous fat. The non-viable dermis is excised to healthy, punctate bleeding dermis. Fascial excision is reserved for subdermal burns that extend well into the subcutaneous tissue, and for those burns which are heavily colonized or infected.

8. If patients arrive with open burn wounds, surgically excise to a healthy wound bed and apply negative pressure wound dressing (NPWD) until granulation tissue is noted. If NPWD is not available, apply gauze dressings moistened with an antimicrobial solution such as 5% mafenide acetate (Sulfamylon) until further surgical debridement can occur.

9. Meshing of split thickness skin grafts will maximize available donor skin. Rarely is there a need to mesh skin wider than 2:1; meshing wider than 3:1 is not recommended due to poor outcomes without comprehensive long term rehabilitation outside of a burn center.

10. Utilize dilute epinephrine solution (1:1,000,000 concentration) to infiltrate subcutaneous tissue by clysis prior to harvesting of donor skin with dermatome. This process will minimize blood loss at the donor site(s). Likewise, dilute epinephrine solution provides topical hemostasis during excision of burns. To control raw surface area bleeding apply a non-adherent dressing (e.g., Telfa), followed by a lap pad soaked in the dilute epinephrine solution.

11. Take the patient to the OR for staged excisions and grafting of the full thickness burns with a goal of complete excision within one week of injury. Consider using a NPWD over fresh autograft with intervening non-adherent layer (e.g. Dermanet or negative pressure Silverlon). If NPWD is not available, sew a bulky bolster dressing over the graft site using a non-adherent layer or silver nylon against the split thickness graft. Leave the post-operative dressing in place for 3-5 days.

12. Following NPWD removal, use Sulfamylon moistened gauze dressings for approximately 5-7 days. When graft interstices are closed transition to a topical agent such as Bacitracin or polymicrobial ointment.

13. Whenever resources are available, perform extensive dressing changes in the OR (not ICU or ward), especially early in the treatment process when wounds remain open. This allows for optimal pain control (with airway protection as needed), improves inspection of wounds, and provides a clean and warm environment.

14. Gram negative bacterial and fungal colonization followed by infection is associated with a high rate of graft loss and increases mortality. Liberal use of dilute Dakin's solution (1/4 strength or 0.125% sodium

hypochlorite) to cleanse colonized burn wounds is recommended. Delay grafting procedures until colonization and infection are controlled.

15. Once the grafts are healed, continue to keep patient clean, using showers when available.

16. Early ambulation and physical therapy, is critical to the long-term functional outcome in burn patients. Once post-operative dressings are removed, perform range of motion of all affected joints.

17. Early and continuous nutrition is vital to wound healing. Even patients who are able to eat may need supplementation to meet calorie goals. Provide approximately 35kcal/kg/day to burned adults. Consult a nutritionist when available. Use a nasoenteric feeding tube to provide a high protein, low fat enteral formula and administer a daily multivitamin.

ADDITIONAL CONSIDERATIONS FOR PEDIATRIC BURN PATIENTS

Deployed surgical teams frequently provide initial care for injured local national children. Burn care for children generally follows adult recommendations, with a few modifications as itemized below.[9] See Appendix C: Pediatric Lund Browder Burn Estimate and Diagram.

Airway patency can be lost early in small children with facial or extensive burns as modest mucosal edema can quickly compromise their small airway; carefully securing the ETT with umbilical tie and adequate sedation is important to prevent unplanned extubation.

Peripheral or intraosseous vascular access may suffice initially, but central venous access is more reliable during formal burn resuscitation; catheters should be sewn in place.

Children with burns under 15% TBSA usually do not need a calculated resuscitation. They can be given 1.5x calculated maintenance rate (see 4-2-1 Rule below[9]) and have diapers weighed for urine output. If they can eat, they should be allowed access to bottle feeds. Some of these children can be supported enterally, with nasoenteric infusions of World Health Organization (WHO) resuscitation formula (1L clean water, 8 tsp sugar, ½ tsp salt, and ½ tsp baking soda).[10]

1. Children with acute burns over 15% of the body surface usually require a calculated resuscitation. Place a bladder catheter (size 6 Fr for infants and 8 Fr for most small children). The Modified Brooke formula (3 mL/kg/%TBSA LR or other isotonic fluid divided over 24 hours, with one-half given during the first 8 hours) is a reasonable starting point. This only provides a starting point for resuscitation, which must be adjusted based on UOP and other indicators of organ perfusion. Goal UOP for children is 0.5-1mL/kg/hr. Decrease or increase the isotonic fluid rate by approximately 20-25% per hour to maintain UOP at 0.5-1mL/kg/hr.

2. Very young children do not have adequate glycogen stores to sustain themselves during resuscitation. Administer a maintenance rate of D5LR to children weighing < 20 kg. Utilize the 4-2-1 rule: 4ml/kg for the first 10kg + 2ml/kg 2nd 10kg + 1ml/kg over 20kg. This maintenance rate is in addition to the isotonic infusion calculated for burn resuscitation and is not titrated.

3. In children with burns > 30% TBSA, early administration of may reduce overall resuscitation volume. If needed, initiate 5% albumin at the child's calculated maintenance rate (use the 4-2-1 rule) and subtract this from the isotonic fluid rate; the albumin rate is maintained while the isotonic fluid is adjusted based on UOP.

4. Monitor resuscitation in children, like adults, based on physical examination, input and output measurements, and analysis of laboratory data. The well-resuscitated child should have alert sensorium,

palpable pulses, and warm distal extremities; urine should be glucose-negative. Monitor electrolytes every 8 hours during the first 72 hours to pick up hypo- and hypernatremia and hypocalcemia. If available, monitor calcium levels and replete to maintain iCa >1.1.

5. Cellulitis is the most common infectious complication and usually presents within 5 days of injury. Prophylactic antibiotics do not diminish this risk and should not be used unless other injuries require them. Most anti-streptococcal antibiotics such as penicillin are successful in eradicating infection. Initial parenteral administration is advised for most children presenting with fever or systemic toxicity.

6. Nutrition is critical for pediatric burn patients. Nasogastric feeding may be started immediately at a low rate in hemodynamically stable patients and tolerance monitored. Start with a standard pediatric enteral formula (e.g. Pediasure) targeting 30-35 kcal/kg/day and 2g/kg/day of protein.

7. Children may rapidly develop tolerance to analgesics and sedatives; dose escalation is commonly required. Ketamine and propofol are useful procedural adjuncts.

When burned at a young age, many children will develop disabling contractures. These are often very amenable to correction which may be performed in theater with adequate staff and resources. Seek early consultation from the USAISR Burn Center (DSN 312-429-2876 (BURN); Commercial (210) 916-2876 or (210) 222-2876; email usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil).

Opportunities for pediatric surgical care provided by Non-Governmental Organizations (NGOs) may be the best option but require the coordinated efforts of the military, host nation, and NGOs.

Pediatric specific questions can be asked through the Burn consult hotline (ask to coordinate with the pediatric intensivist).

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All burn casualties (as identified by diagnosis code).

INTENT (EXPECTED OUTCOMES)

1. All burn patients with GCS < 8, symptomatic inhalation injury, deep facial burns, or burns ≥ 40% receive a definitive airway (endotracheal tube, cricothyroidotomy, or tracheostomy) prior to interfacility transfer (Role 2-Role 3 or Role 3-Role 4).
2. All patients with burns ≥ 20% TBSA receive formal fluid resuscitation documented on burn flow sheet.
3. Escharotomy is performed for circumferential full thickness burns.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with burn ≥ 40% TBSA or GCS < 8 or inhalation injury with AIS severity code > 1 or facial burns with face AIS >2 who receive a definitive airway (endotracheal tube, cricothyroidotomy, or tracheostomy) at first surgical capability.

2. Number and percentage of patients with burn ≥ 20% TBSA who have burn flow sheet completed.

3. Number and percentage of patients with circumferential burn who receive escharotomy.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- Burn Navigator data

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG. It is the responsibility of the nurse assigned to the trauma patient to ensure the Burn Navigator or Burn Flow Sheet (Appendix D) is initiated and completed.

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APPENDIX A: PHYSICIAN'S ORDER

1. **Diagnosis**: _____
2. **Condition**: VSI SI NSI Category: Nation/Service (e.g., US/USA, HN/IA)
3. **Allergies**: Unknown NKDA Other
4. **Monitoring**
   - 4.1. Vital signs: Q _____ hrs
   - 4.2. Urine output: Q _____ hrs
   - 4.3. Transduce bladder pressure Q _____ hrs
   - 4.4. Neurovascular/Doppler pulse checks Q _____ hrs
   - 4.5. Transduce: _____CVP _____A-line _____Ventriculostomy
   - 4.6. Neuro checks: Q _____ hrs
   - 4.7. Cardiac monitor: Yes / No
5. **Activity**
   - 5.1. _____Bedrest _____Chair Q shift _____ Ad lib _____ Roll Q 2 hrs
   - 5.2. _____Passive ROM to UE and LE Q shift
   - 5.3. Spine precautions: _____C-Collar /C-Spine _____TLS Spine
6. **Wound Care**
   - 6.1. _____NS wet to dry BID to: _____
   - 6.2. _____Dakin's wet to dry BID to: _____
   - 6.3. _____VAC dressing to _____75 mm Hg _____125 mm Hg
   - 6.4. _____Abdominal closure drains to LWS
   - 6.5. _____Other: _____
7. **Tubes/Drains**
   - 7.1. _____NGT to LCWS or _____ OGT to LCWS
   - 7.2. _____Place DHT _____Nasal _____Oral and confirm via KUB
   - 7.3. _____Foley to gravity
   - 7.4. _____Flush feeding tube Q shift with 30 mL water
   - 7.5. _____JP(s) to bulb suction; strip tubing Q 4 hrs and PRN
   - 7.6. _____Chest tube to: _____20 cm H_2O suction (circle: R L Both) or _____Water seal: (circle: R L Both)
8. **Nursing**
   - 8.1. Strict I & O and document on the JTTS Burn Resuscitation Flow Sheet Q 1 hr for burn > 20% TBSA
   - 8.2. _____Clear dressing to Art Line/CVC, change Q 7D and prn
   - 8.3. _____Bair Hugger until temperature > 36° C
   - 8.4. _____Lacrilube OU Q 6 hrs while sedated
   - 8.5. _____Oral care Q 4 hrs; with toothbrush Q 12 hrs
   - 8.6. _____Maintain HOB elevated 45°
   - 8.7. _____Fingerstick glucose Q _____ hrs
   - 8.8. _____Routine ostomy care
   - 8.9. _____Ext fix pin site care
   - 8.10. _____Trach site care Q shift
   - 8.11. _____Incentive spirometry Q 1 hrs while awake; cough & deep breath Q 1 hr while awake
9. **Diet**
   - 9.1. _____NPO
   - 9.2. _____PO diet
   - 9.3. _____TPN per Nutrition orders
   - 9.4. _____Tube Feeding: _____@ _____mL/hr OR _____Advance per protocol

10. Burn Resuscitation (%TBSA > 20%)

10.1. If available, initiate Burn Navigator computer decision support system and follow prompts on screen. System will provide recommendations for burn fluid resuscitation, provider should use clinical judgment and consider entire clinical scenario when interpreting recommendations.

10.2. Start initial infusion of Lactated Ringers (LR) at _____ml/hr IV (10 x % TBSA >40 kg <80 kg) (Add 100 ml/hr for every 10 kg > 80 Kg)

10.3. Titrate resuscitation IVF as follows to maintain target UOP (Adult: 30-50 mL/hr; Children: 1.0 mL/kg/hr)

- Decrease rate of LR by 20% if UOP is greater than 50 mL/hr for 2 consecutive hrs
- Increase rate of LR by 20% if UOP is less than 30 mL/hr (adults) or pediatric target UOP for 2 consecutive hrs

10.4. If CVP > 10 cm H_2O and patient still hypotensive (SBP < 90 mm Hg), begin vasopressin gtt at 0.02 – 0.04 Units/min

10.5. Post burn day #2 (Check all that apply)

_____Continue LR at _____ mL/hr IV

_____Begin _____@ _____mL/hr IV for insensible losses

_____Start Albumin 5% at _____ mL/hr IV ((0.3 – 0.5 x %TBSA x wt in kg) / 24) for 24 hrs

11. IVF (% TBSA ≤ 20%): ____LR ____NS ____D5NS ____D5LR ____D5 .45NS ____+ KCl 20 meq/L @ ____mL/hr

12. Laboratory Studies & Radiology

12.1. _____CBC, Chem-7, Ca/Mg/Phos: _____ ON ADMIT _____DAILY @ 0300

12.2. _____PT/INR _____TEG _____Lactate: _____ ON ADMIT _____DAILY @ 0300

12.3. _____LFTs _____Amylase _____Lipase: _____ ON ADMIT _____DAILY @ 0300

12.4. _____ABG: _____ON ADMIT _____ 30 mins after ventilator change _____Q AM (while on ventilator)

12.5. _____Triglyceride levels after 48 hours on Propofol

12.6. _____Portable AP CXR on admission

12.7. _____Portable AP CXR Q AM

13. Prophylaxis

13.1. _____Protonix 40 mg IV Q day

13.2. _____Lovenox 30 mg SQ BID OR _____Heparin 5000 U SQ TID starting_____

13.3. _____Pneumatic compression boots

14. Ventilator Settings

14.1. Mode: _____ SIMV _____CMV _____AC _____CPAP

14.2. FiO_2: _____%

14.3. Rate: _____

14.4. Tidal Volume: _____ cc

14.5. PEEP: _____

14.6. Pressure Support: _____

14.7. Insp Pressure: _____

14.8. I/E Ratio: _____

14.9. _____ APRV: Phi_____ Plow_____ Thi_____ Tlow_____ FiO_2: _____%

14.10. _____Maintain patient in soft restraints while on ventilator

14.11. _____Wean FiO_2 to keep SpO_2 > 90-96% or PaO_2 >60-100 mmHg[1]

14.12. _____nebulizer/MDIs: _____Albuterol _____Atrovent _____Xopenex Unit Dose Q 4 hrs

15. Analgesia/Sedation/PRN Medications

15.1. Analgesia/sedation goal is Richmond Agitation Sedation Scale (RASS), scale below, of 0 (alert and calm) to -3 (moderate sedation). Hold continuous infusion for RASS of -4 (deep sedation) or higher.

15.2. _____Propofol gtt at _____ mcg/kg/min, titrate up to 50 mcg/kg/min.

15.3. _____Fentanyl gtt at _____mcg/hr titrate up to 250 mcg/hr; for analgesia may give 25-100 mcg IVP Q 15 minutes for acute pain or burn wound care.

15.4. _____Morphine gtt at _____mg/hr, titrate up to 10 mg/hr, for analgesia may give 2-10 mg IVP Q 15 minutes for pain or burn wound care.

15.5. _____Versed gtt at _____ mg/hr, titrate up to 10 mg/hr ; may give 2-5 mg IVP Q 15 minutes for acute agitation or burn wound care.

15.6. _____Ativan gtt at _____mg/hr, titrate up to 10 mg/hr; may give 1-4 mg IVP Q 2-4 hours for acute agitation.

15.7. Important: Hold continuous IV analgesia/sedation at 0600 hrs for a RASS of -4 or -5. If further analgesia/sedation is indicated, start medications at ½ of previous dose and titrate for target RASS.

15.8. _____Morphine 1-5 mg IV Q 15 minutes prn pain

15.9. _____Fentanyl 25-100 mcg IV Q 15 minutes prn pain

15.10. _____Ativan 1-5 mg IV Q 2-4 hrs prn agitation

15.11. _____Percocet 1-2 tablets po Q 4 hrs prn pain

15.12. _____Tylenol _____ mg / Gm PO / NGT / PR Q _____ hrs PRN for fever or pain

15.13. _____Morphine PCA; Program (circle one): 1 2 3 4

15.14. _____Zofran 4-8 mg IVP Q 4 hrs PRN for nausea/vomiting

15.15. _____Dulcolax 5 mg PO / PR Q day PRN for constipation

16. Specific Burn Wound Care

16.1. Cleanse and debride facial burn wounds with Sterile Water or (0.9% NaCl) Normal Saline Q 12 hrs, use a washcloth or 4x4s to remove drainage/eschar

16.2. Cleanse and debride trunk and extremities with chlorhexidine gluconate 4% solution (Hibiclens) and Sterile Water or Normal Saline, before prescribed dressing changes

16.3. Change fasciotomy dressings and outer gauze dressings daily and as needed; moisten with sterile water Q 6 hours and as needed to keep damp, not soaking wet.

Face & Ears

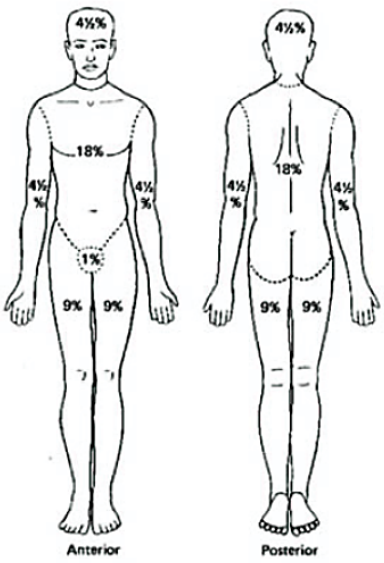
_____Bacitracin ointment BID &PRN
_____Sulfamylon cream to ears BID & PRN
_____5% Sulfamylon solution dressing changes Q AM and moisten every 6 hrs
_____Bacitracin ophth ointment: apply OU Q 6 hrs

BUEs & Hands, BLEs, Chest, Abdomen & Perineum

_____Silvadine cream Q AM & PRN (*deep partial & full thickness*)
_____Sulfamylon cream Q PM & PRN (*deep partial & full thickness*)
_____5% Sulfamylon solution – change Q AM & moisten Q 6 hrs (*superficial burns)*
_____Silver nylon dressing and moisten with sterile water approximately every 6 hrs PRN; dressings may be left in place for 72 hrs)

Back

_____Silvadine cream Q AM & PRN (*deep partial & full thickness burns*)
_____Sulfamylon cream Q PM & PRN (*deep partial & full thickness burns*)
_____5% Sulfamylon solution dressings changed Q AM and moisten Q 6 hrs
_____ Silver nylon dressing and moisten with sterile water approximately every 6 hrs PRN; dressings may be left in place for 72 hrs)



Rule of Nines to calculate initial burn size

17. Other Orders

17.1. _____

17.2. _____

18. Notify Physician if: SBP < _____, MAP < _____, HR <_____ or > _____, SaO_2 < _____%, T > _____, UOP < 30 mL/hour for 2 consecutive hours

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RICHMOND AGITATION SEDATION SCALE (RASS)

Score	Term	Description
+4	Combative	Overtly combative or violent; immediate danger to staff
+3	Very agitated	Pulls on or removes tube(s) or catheter(s) or has aggressive behavior toward staff
+2	Agitated	Frequent nonpurposeful movement or patient–ventilator
+1	Restless	Anxious or apprehensive but movements not aggressive or vigorous
0	Alert and calm	Spontaneously pays attention to caregiver
-1	Drowsy	Not fully alert, but has sustained (more than 10 seconds) awakening, with eye contact, to voice
-2	Light sedation	Briefly (less than 10 seconds) awakens with eye contact to voice
-3	Moderate sedation	Any movement (but no eye contact) to voice
-4	Deep sedation	No response to voice, but any movement to physical stimulation
-5	Unarousable	No response to voice or physical stimulation

APPENDIX B: ADULT LUND BROWDER BURN ESTIMATE & DIAGRAM

Total Area front/back (circumferential)		one side--anterior	one side--posterior	Do not include in total TBSA			
	Adult	adult	adult	1st ○	2nd ○	3rd ○	TBSA
Head	7	3.5	3.5				0
Neck	2	1	1				0
Anterior trunk*	13	13	0				0
Posterior trunk*	13	0	13				0
Right buttock	2.5	na	2.5				0
Left buttock	2.5	na	2.5				0
Genitalia	1	1	na				0
Right upper arm	4	2	2				0
Left upper arm	4	2	2				0
Right lower arm	3	1.5	1.5				0
Left lower arm	3	1.5	1.5				0
Right hand	2.5	1.25	1.25				0
Left hand	2.5	1.25	1.25				0
Right thigh	9.5	4.75	4.75				0
Left thigh	9.5	4.75	4.75				0
Right leg	7	3.5	3.5				0
Left leg	7	3.5	3.5				0
Right foot	3.5	1.75	1.75				0
Left foot	3.5	1.75	1.75				0
	100	48	52	0	0	0	0

Age:	
Sex:	
Weight:	

Patient Identification

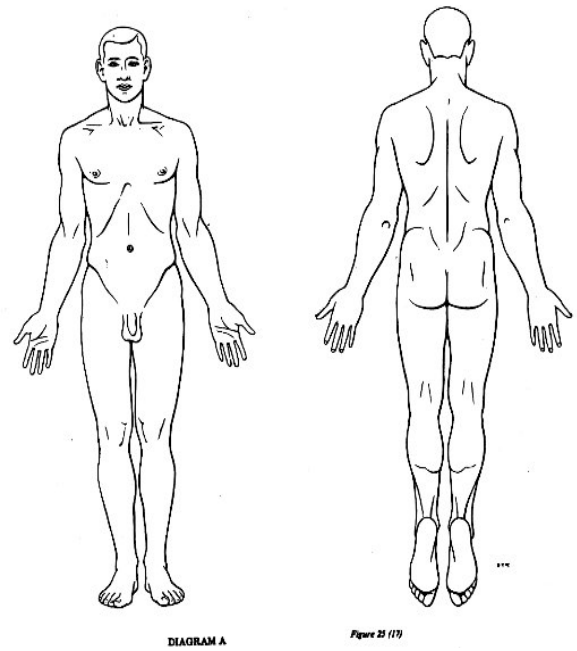
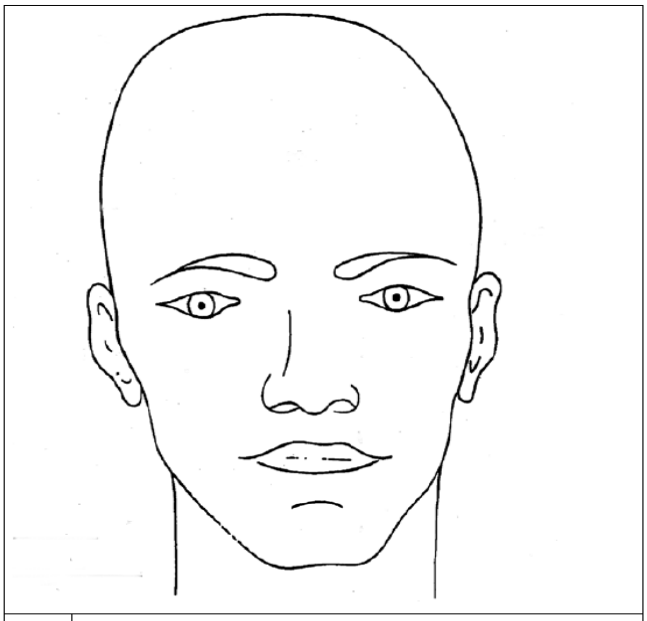


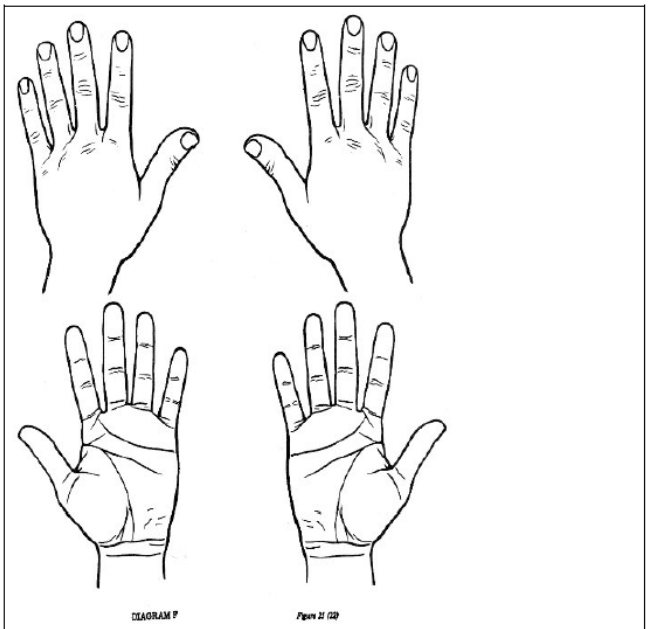
DIAGRAM A

ADULT BURN DIAGRAM: HEAD



Date:	
Name:	

ADULT BURN DIAGRAM: HANDS

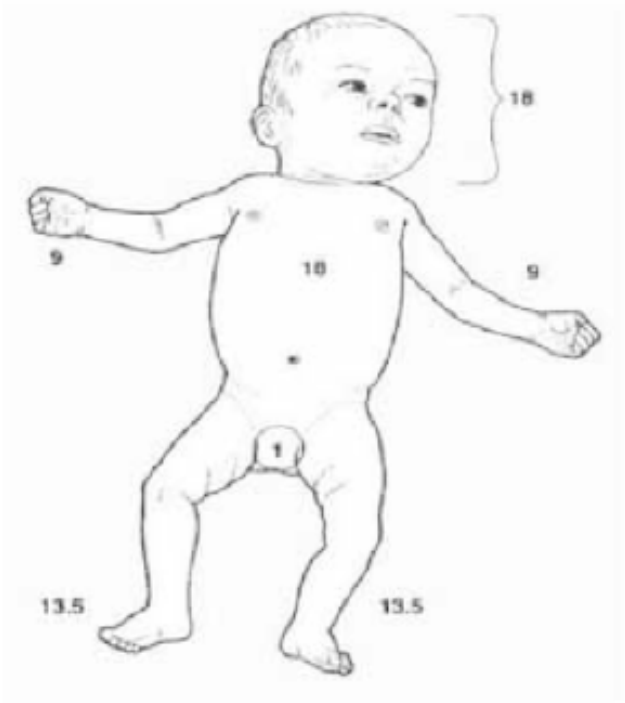


Date:	
2nd:	
3rd:	
Total:	

APPENDIX C: PEDIATRIC LUND BROWDER BURN ESTIMATE & DIAGRAM

INFANT BURN ESTIMATE AND DIAGRAM

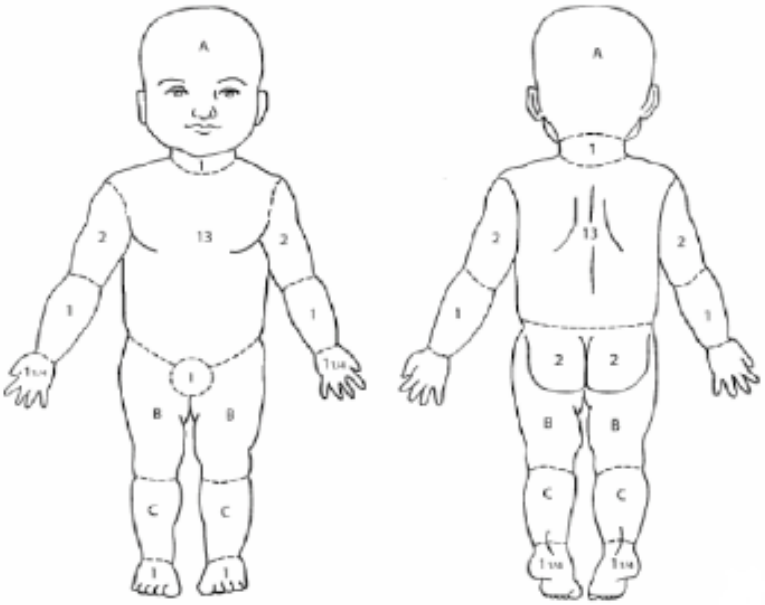
Total Area front/back (circumferential)	Birth to 1 year	Do not include in total TBSA 1st	2nd °	3rd °	TBSA
Head	19				0
Neck	2				0
Anterior trunk*	13				0
Posterior trunk*	13				0
Right buttock	2.5				0
Left buttock	2.5				0
Genitalia	1				0
Right upper arm	4				0
Left upper arm	4				0
Right lower arm	3				0
Left lower arm	3				0
Right hand	2.5				0
Left hand	2.5				0
Right thigh	5.5				0
Left thigh	5.5				0
Right leg	5				0
Left leg	5				0
Right foot	3.5				0
Left foot	3.5				0



CHILD BURN ESTIMATE AND DIAGRAM

Total Area front/back (circumferential)	1 to 4 years	5 to 9 years	10 to 14 years	15 years	Do not include in total TBSA 1st	2nd °	3rd °	TBSA
Head	17	13	11	9				0
Neck	2	2	2	2				0
Anterior trunk*	13	13	13	13				0
Posterior trunk*	13	13	13	13				0
Right buttock	2.5	2.5	2.5	2.5				0
Left buttock	2.5	2.5	2.5	2.5				0
Genitalia	1	1	1	1				0
Right upper arm	4	4	4	4				0
Left upper arm	4	4	4	4				0
Right lower arm	3	3	3	3				0
Left lower arm	3	3	3	3				0
Right hand	2.5	2.5	2.5	2.5				0
Left hand	2.5	2.5	2.5	2.5				0
Right thigh	6.5	8	8.5	9				0
Left thigh	6.5	8	8.5	9				0
Right leg	5	5.5	6	6.5				0
Left leg	5	5.5	6	6.5				0
Right foot	3.5	3.5	3.5	3.5				0
Left foot	3.5	3.5	3.5	3.5				0

1	
2	
3	



APPENDIX D: JTS BURN RESUSCITATION PROTOCOL, WORKSHEET & FLOW SHEET

THE BURN RESUSCITATION PROTOCOL

The JTS Burn Resuscitation Flow Sheet provides clinicians with a tool to track burn resuscitation over a 72-hour period. Conceptually, the flow sheet creates a continuum between clinicians during the resuscitation phase. This format allows clinicians to accurately trend intake and output, hemodynamics and vasoactive medications, and promotes optimal outcomes through precise patient management.

1. The clinicians at the first medical facility where the patient receives treatment will initiate the JTTS Burn Resuscitation Flow Sheet. This treatment facility will be listed in the "Initial Treatment Facility" block. Clinicians at any level of care may initiate the flow sheet.
2. Record today's date in the "Date" block according to the current date where the recorder is located. (Do not adjust this date based on the patient's origin or destination; use the local date).
3. Record the patient's full name and social security number in the "Name" and "SSN" blocks. Document name and SSN on all three pages of the flow sheet.
4. Record the patient's weight in the "Pre-burn est. wt (kg)" block. In theater, record the estimated weight based on the patient's weight prior to injury or "dry weight." If a patient presents prior to initiating resuscitation and an accurate weight can be easily obtained without delaying care, providers are urged to weigh the patient and record the result.
5. Record the total body surface area burned in the "%TBSA" block (do not include superficial injury in this calculation). Clinicians will assess the burn size and use this value to determine fluid resuscitation requirements. Following the patient's transfer to another facility, the receiving clinicians are required to "re-map" the burn, considering that burn wound may "convert" (or become deeper) between assessments at one facility or during transport between two facilities.
6. Burn Fluid Resuscitation Calculations: Use the Rule of Tens to determine fluid requirements for the first 24 hours post-burn. (Rule of Tens: 10 x % TBSA > 40 kg and < 80 kg; if > 80 kg, add 100 ml/hr for every 10 kg > 80 kg). At 8-12 hours post-burn, reevaluate resuscitation efforts and assess for potential over resuscitation. If fluid resuscitation needs exceed 6 ml/kg/%TBSA in 24 hours, consider the guidelines established in the *Emergency War Surgery Handbook* and the addendum to the handbook, "Recommendations for Level IV Burn Care." *[LRMC specific: USAISR/BAMC Burn Unit Guidelines can also be found in the LRMC Burn Care Guide.]*
    a) Clinicians at the first medical facility to treat the patient will calculate the fluid requirements for the first 24 hours post-burn and record the amount in the block on page 1 labeled "Estimated fluid volume patients is administered,"
    b) Clinicians will record the "fluid volume ACTUALLY received" during the first 24 hours of resuscitation in the block labeled as such at the top of page 2. This amount will equal the actual volume delivered during the first 24 hours (as recorded on page 1).
    c) Clinicians will transcribe the 24-hour fluid volume totals recorded on pages 1 and 2 of the flow sheet onto page 3 in the block labeled "fluid volume ACTUALLY received." This allows clinicians to see the first 48-hour totals as the patient enters into the last 24 hours of the 72-hour period.
7. Record the local date and time that the patient was injured in the "Date & Time of Injury" block. This date and time IS NOT the time that the patient arrived at the medical facility, but rather the date and time of INJURY.

8. Record the facility name and/or treatment team in the "Tx Site/Team" block. The facility name/team name is the team of clinicians who managed the patient during each specified hour on the flow sheet. This team may reside within a facility, in which case the facility name is recorded, or be a transport team (e.g., MEDEVAC, CCATT, AEROVAC).
9. "Hr from burn" is defined as the number of hours after the burn injury occurred. If a patient does not arrive at a medical facility until 3 hours after the burn occurred, clinicians do not record hourly values for hours 1-3 but begin recording the row marked "4th" hour post-burn. To the extent possible, clinicians should confer with level I and II clinicians to determine fluid intake and urine output. These totals may be record in the 3rd hour row.
10. Record the current local time of the recorder in the "Local Time" block, be it Baghdad Time, Berlin Time, ZULU, or CST. As with date do not adjust time based on the patient's origin or destination; use the local time.
11. Record the total volume of crystalloids and colloids administered in the "crystalloid/colloid" column, not the specific fluids delivered. Clinicians should refer to the critical care flow sheet to determine the fluids types and volumes. This burn flow sheet is designed to track total volumes. Examples of crystalloid solutions are LR, 0.45% NS, 0.9% NS, D5W, and D5LR. Examples of colloids are Albumin (5% or 25%), blood products, and other volume expanders such as dextran, hespan, or hextend. The use of hydroxyl ethyl starch (hextend) as a resuscitation fluid is no longer recommended.
12. Document the name, dosage, and rate of vasoactive agents in the "Pressors" block. Patients who receive vasoactive agents may also have invasive pressure monitoring devices (e.g., arterial line, central venous line, pulmonary artery catheter), in which case significant values should be recorded in the "BP" and MAP (>55)/CVP" columns.
13. For additional burn resuscitation guidelines refer to the *Emergency War Surgery Handbook* and the *Recommendations for Level IV Burn Care*.

JTS BURN RESUSCITATION WORK SHEET

Initiate AFTER *completion of trauma assessment and interventions*
Adults only: *Refer to Additional Considerations for Pediatric Burn Patients in the Burn Care CPG.*

1. Contact USAISR Burn Center (DSN 312-429-2876) or email: usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil

Date/Time contact: _____POC:_____ by:_____

2. Estimated Pre-burn Weight (wt): _____kg (Average Service Members are 82 ± 15 kg)

3. Estimate Total Burn Surface Area (TBSA) using Rule of Nines (refine with Lund-Browder after wounds are cleansed)

Partial thickness (2nd)_____% + Full thickness (3rd)_____% = **TBSA_____%**

IF TBSA >40%: intubate (use ETT ≥ 7.5 fr to facilitate bronchoscopy)

IF TBSA <15%: formal resuscitation may not be required, provide maintenance and/or oral fluids

4. Standard Burn Resuscitation Fluid: Lactated Ringers (LR) or Plasmalyte

5. Calculate INITIAL Fluid Rate using Rule of 10 (adults):

- IF wt < 40kg: 2ml x %TBSA_____ x wt(kg)_____ ÷ 16 = _____ml/hr
- IF wt ≥ 40kg: %TBSA_____ x 10 = _____ml/hr
  - IF wt > 80kg: add 100ml/hr to initial rate for every 10 kg>80: adjusted initial fluid rate = _____ml/hr
  - (Example: 100kg patient with 50% TBSA burn = 50% x 10 = 500 ml + 200 ml = 700 ml for first hour)

6. If Inhalation Injury Present: administer aerosolized heparin in albuterol (5,000 units Q4 hours)

7. Titrate Resuscitation Fluid: maintain target **UOP 30-50ml/hr** (Q 1 hour)

- If rhabdomyolysis present: use target UOP 75-100 ml/hr (Contact USAISR Burn Center DSN 312-429-2876)
- Goals: UOP >30 but <50ml/hr; adequate tissue perfusion (normalized lactate/base deficit), MAP >55 mmHg
- Minimum fluid rate 125mL/hr LR
- * Avoid fluid boluses
- ** Too much fluid as dangerous as too little

High risk for over resuscitation/abdominal compartment syndrome:

- If hourly rate >1500mL/hr x 2 hrs OR
- If total 24 hr volume exceeds: wt(kg) x 250ml= _____ml (includes all infused fluids)
  - Contact USAISR Burn Center (DSN 312-429-2876)
  - Consider adjuncts (below)
  - Check bladder pressures Q4hrs (>20 mmHg notify physician)
  - Avoid surgical decompression (significant mortality risk in burns)

Adjuncts:

1. Colloids: 5% albumin/FFP (Use hextend only if others unavailable; Hextend, as a resuscitation fluid, is no longer recommended.)
   - * Colloids not preferred until hour 8-12; can consider earlier in difficult resuscitation
   - Infuse at ml/hr according to chart below based on adult patient weight and burn size
2. Vasopressors: Contact USAISR Burn Center (DSN 312-429-2876)

5% Albumin Infusion (ml/hr)	30-49%TBSA	50-69% TBSA	70-100% TBSA
<70 kg	30	70	110
70-90 kg	40	80	140
>90 kg	50	90	160

Ensure adequate volume (CVP trend 6-8 cm H_2O); **maintain MAP > 55 mmHg**

- Maintain ionized Ca >1.1 mmol/L
- Start with vasopressin 0.04 units/min. **DO NOT TITRATE**
- Second line pressor: norepinepherine 2-20mcg/min
- Refractory shock: consider epinephrine or phenylephrine infusion
- Refractory shock: consider adrenal insufficiency, give hydrocortisone 100mg IV Q8 hrs
- Manage acidemia (pH<7.2): use ventilator interventions first, then bicarbonate or THAM infusion
- Renal replacement therapy if available (Contact USAISR Burn Center DSN 312-429-2876)

Assessment/Interventions:

- Complete full secondary trauma exam
- Ensure thermoregulation; administer warmed fluids; cover with space blanket; elevate burned extremities
- Superficial burn (1st degree): Sunburn, no blister, blanch readily; NOT included in TBSA
- Partial thickness (2nd degree): Blanch, moist, blisters, sensate
- Full thickness (3rd degree): Leathery, white, non-blanching, dry, insensate, thrombosed vessels
- Protect eyes with moisture shields if corneas exposed or blink reflex slow; apply ophthalmic erythromycin ointment at least Q2hrs.
- **Prompt intubation for facial burns, suspected inhalation injury, TBSA >40%**
    - Anticipate induction-associated hypotension.
    - Secure ETT with cloth tie, not adhesive tape
    - Reassess ETT position at teeth Q1 hour as edema develops and resolves
    - Intubated patients require oro/naso-gastric tube for decompression.
    - Administer IV proton-pump inhibitor.
- Monitor bladder pressure at least Q4hrs for large burns or high volume resuscitations
    - Abdominal compartment syndrome: decreased UOP, increased pulmonary pressures, difficulty ventilating, bladder pressure remains > 20 mmHg
    - Avoid decompressive laparotomy; consider percutaneous peritoneal drainage
    - Reduce crystalloid volume using colloid or vasopressors
- Monitor pulses hourly: palmar arch, dorsalis pedis, posterior tibial with Doppler
    - Consider escharotomy if signal diminished; refer to Burn CPG for technique (Call USAISR Burn Center DSN 312-429-2876)
- Monitor extremity compartment pressures as clinically indicated
    - Elevate burned extremities at all times
    - Extremity compartment syndrome: pain, paresthesia, pallor, paralysis, pulselessness (late sign)
    - Fasciotomy may be required
- Wound care
    - Thoroughly cleanse burn wounds, preferably in Operating Room
    - Select topical antimicrobial in consultation with Burn Surgeon (Call USAISR Burn Center DSN 312-429-2876) based on product availability, expected transport time, etc.
    - Acceptable to cover burns with dry sheets or clean dressings for first 48 hours
- All definitive burn surgery done at USAISR Burn Center for US Service Members (DSN 312-429-2876)

JTS BURN RESUSCITATION FLOW SHEET (1 of 3)

Date		Initial Treatment Facility							
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary			
Date &Time of Injury				BAMC/ISR Burn Team DSN 312-429-2876: Yes No					

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8 mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	1st								
	2nd								
	3rd								
	4th								
	5th								
	6th								
	7th								
	8th								
	9th								
	10th								
	11th								
	12th								
	13th								
	14th								
	15th								
	16th								
	17th								
	18th								
	19th								
	20th								
	21st								
	22nd								
	23rd								
	24th								
Total Fluids:					*Titrate LR to maintain adequate UOP (30-50ml/hr) and perfusion				

JTS BURN RESUSCITATION FLOW SHEET (2 of 3)

Date		Initial Treatment Facility							
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary			
Date &Time of Injury				BAMC/ISR Burn Team DSN 312-429-2876: Yes No					

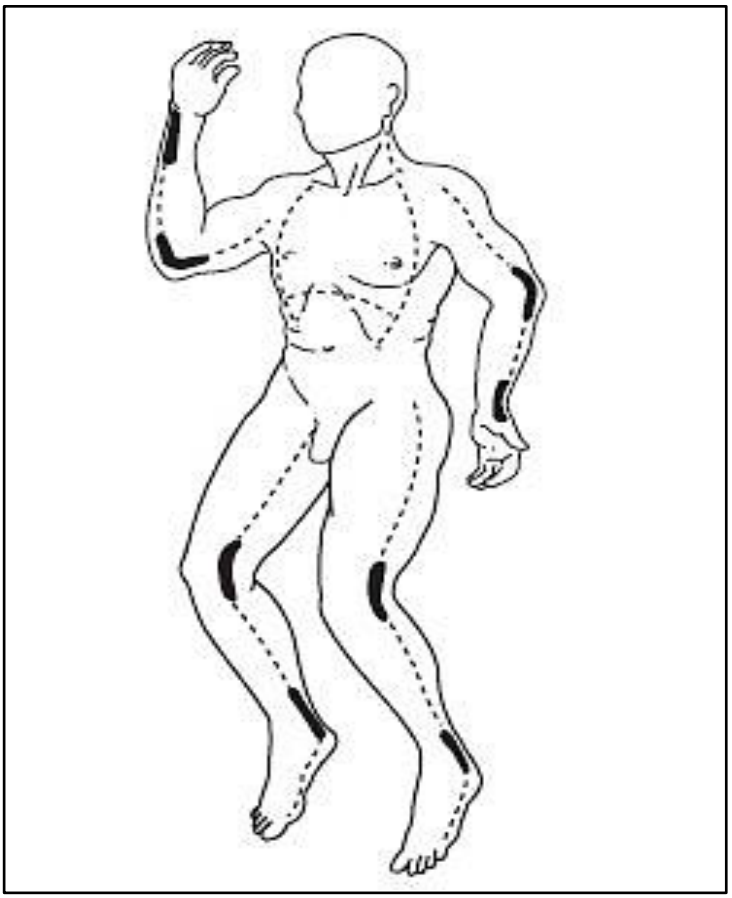
Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8 mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	25th								
	26th								
	27th								
	28th								
	29th								
	30th								
	31st								
	32nd								
	33rd								
	34th								
	35th								
	36th								
	37th								
	38th								
	39th								
	40th								
	41st								
	42nd								
	43rd								
	44th								
	45th								
	46th								
	47th								
	48th								
Total Fluids:					*Titrate LR to maintain adequate UOP (30-50ml/hr) and perfusion				

JTS BURN RESUSCITATION FLOW SHEET (3 of 3)

Date		Initial Treatment Facility				
Name		**SSN**	**Pre-burn estimated weight (kg)**	**%TBSA (Do not include superficial 1st degree burn)**	**Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR**	**Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary**
Date &Time of Injury				**BAMC/ISR Burn Team DSN 312-429-2876: Yes No**		

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8 mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	49th								
	50th								
	51st								
	52nd								
	53rd								
	54th								
	55th								
	56th								
	57th								
	58th								
	59th								
	60th								
	61st								
	62nd								
	63rd								
	64th								
	65th								
	66th								
	67th								
	68th								
	69th								
	70th								
	71st								
	72nd								
Total Fluids:					***Titrate LR to maintain adequate UOP (30-50ml/hr) and perfusion**				

APPENDIX E: ESCHAROTOMY FIGURE



Dashed lines indicate the preferred sites for escharotomy incisions. **Bold lines** indicate the importance of extending the incision over involved major joints. Incisions are made through the burned skin into the underlying subcutaneous fat using a scalpel or electrocautery. For a thoracic escharotomy, begin incision in the midclavicular lines. Continue the incision along the anterior axillary lines down to the level of the costal margin. Extend the incision across the epigastrium as needed. For an extremity escharotomy, make the incision through the eschar along the midmedial or midlateral join line.

Figure 26.2-1 Emergency War Surgery; Fourth United States Revision; 2013 (page 379).

APPENDIX F: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Burn Wound Management in Prolonged Field Care (CPG ID: 57)

This Role 1 prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines, when evacuation to higher level of care is not immediately possible.

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INTRODUCTION

This Role 1, prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines, when evacuation to higher level of care is not immediately possible. A provider of PFC must first and foremost be an expert in TCCC. This Clinical Practice Guideline (CPG) is meant to provide medical professionals who encounter burns in austere environments with evidence-based guidance. Recommendations follow a "best," "better," "minimum" format that provides alternate or improvised methods when optimal hospital options are unavailable. A more comprehensive guideline for burn care is available in the Joint Trauma System Clinical Practice Guideline (JTS CPG) for Burn Care at https://jts.health.mil/index.cfm/PI_CPGs/cpgs

URGENT BURN CARE

Burns covering >20% of the total body surface area (TBSA), or those with smoke inhalation injury (and airway or breathing problems), are life threatening. Burns that affect vision, decrease hand function, or cause severe pain can take the warfighter out of action.

Hypothermia risk is high in burn patients. Anticipate that all burn casualties will become hypothermic and take immediate measures to prevent it by covering patient. Aggressively rewarm if temperature falls below 36°C (96.8°F).

Telemedicine: Management of burns is complex. Also, burns are highly visual and a lot can be communicated via pictures or video. Establish telemedicine consult as soon as possible.

US Army Institute of Surgical Research, (USAISR) Burn Center

DSN 312-429-2876 (429-BURN)

Commercial (210) 916-2876 or (210) 222-2876

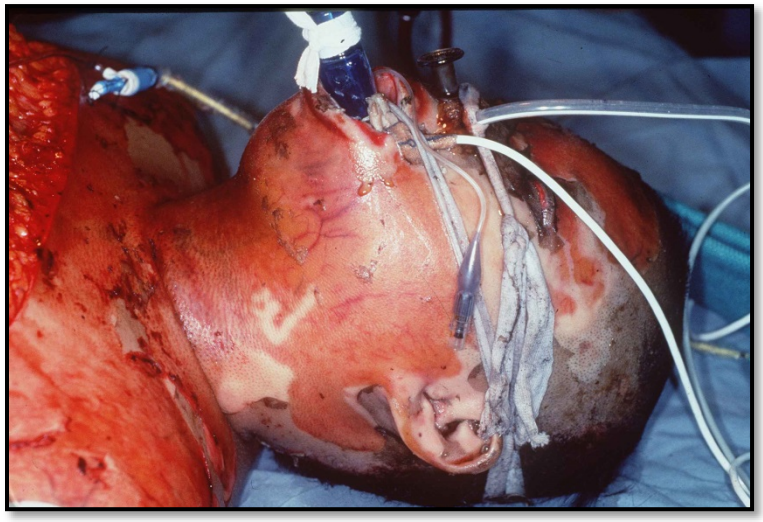
E-mail to usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil

AIRWAY MANAGEMENT

Goal: Avoid airway obstruction due to inhalation injury or burn-induced swelling.

- Patients with smoke inhalation injury may present with a range of symptoms in terms of severity.
- Patients with severely symptomatic smoke inhalation injury (e.g., respiratory distress, stridor) require immediate definitive airway (cuffed tube in trachea) because they are at risk of immediate airway loss. Oxygenate and ventilate.
- All patients with burns covering >40% TBSA should be intubated because total-body swelling will tend to obstruct the airway. Patients with facial burns around the mouth may require intubation (Figure 1).

Figure 1. Severe facial burns with airway secured.



- **Best:** Rapid-sequence intubation by skilled provider, followed by continuous sedation and airway maintenance, supplemental oxygen, portable ventilator.
- **Better:** Cricothyroidotomy followed by continuous sedation and airway maintenance, supplemental oxygen via an oxygen concentrator, portable ventilator.
- **Minimum:** Cricothyroidotomy, ketamine, ambu bag with positive end-expiratory pressure (PEEP) valve.

NOTES:

- Patients with mild symptoms of smoke inhalation injury (e.g., some cough, no respiratory distress) can be observed.
- Burns or explosions in a closed space are associated with higher risk of inhalation injury than burns occurring in open areas.
- Supraglottic airway (e.g., laryngeal mask airway [LMA], King LT [Ambu, http://www.ambuusa.com/], or Combitube [Medtronic Minimally Invasive Therapies, http://www.medtronic.com/covidien]) is not appropriate because edema will continue to increase over 48 hours and these tubes do not overcome vocal-cord edema.
- Endotracheal tube must be secured circumferentially around the neck using cotton ties or similar. Tape does not stick to the face well enough in burn patients.
- Place nasogastric (or orogastric) tube to decompress stomach in intubated patients.
- Perform frequent endotracheal suction of intubated patients to ensure tube patency and remove mucus/debris (approximately once an hour or more frequently if oxygen saturation [SpO2] drops).
- If there is evidence of inhalation injury, use 3–5mL of endotracheal saline to facilitate suctioning and prevent tube insipation and obstruction.
- Monitoring end-tidal CO2 is an important capability for all intubated patients. A rising end-tidal CO2 could indicate clogging of endotracheal tube or poor ventilation from another cause (e.g., bronchospasm, tight eschar across chest).

- Use PEEP on all intubated patients.
- Perform a surgical escharotomy of the chest for tight, circumferential, full-thickness burns that impair breathing. Incision goes through the full thickness of the burn and into the fat (Appendix A). Expect some pain and bleeding.
- Use bronchodilators (e.g., albuterol inhaler) for intubated patients with inhalation injury, if available.

Ventilator management of burn patients can be complicated and evolve as pulmonary conditions change due to volume overload/edema and acute respiratory distress syndrome (ARDS). Telemedicine consultation with skilled providers is recommended.

ASSESS BURN SIZE

Goal: Accurately identify burn wound size to identify appropriate fluid resuscitation needs.

Estimating burn wound size may be difficult. Engage remote specialty consultants early. If possible, send pictures of wounds that have been cleaned and debrided.

- **Best:** When wounds are cleaned/debrided, recalculate TBSA using the Lund-Browder chart (Appendix B).
- **Better:** Same as minimum.
- **Minimum:** For small wounds, calculate the size of the wound by using the patient's hand size (including fingers) to represent a 1% TBSA. For larger wounds, calculate the patient's initial burn size using the Rule of Nines (Appendix C).

NOTE: Significant over- or underestimation of burn wound size (by more than 10%) may lead to significant morbidity. Underestimation may lead to under-resuscitation and organ failure (i.e., renal failure, shock); overestimation may lead to resuscitation morbidity (i.e., respiratory failure, compartment syndromes).

1st degree (superficial) burns look like a mild-moderate sunburn. They appear red, blanch readily, do not blister, and hurt when touched. Do NOT include these wounds in the estimation of TBSA used for fluid resuscitation (Figure 2).

2nd degree (partial thickness) burns are moist, blister, blanch, and hurt. Include these wounds in the TBSA estimation (Figure 3).

3rd degree (full thickness) burns appear leathery, dry, nonblanching, do not hurt, and often contain thrombosed vessels that are visible. Include these wounds in the TBSA estimation (Figure 4).

Figure 2. First degree burns. (Do not include these wounds in the TBSA estimate!)

A. Sunburn

B. Mostly first degree burns with small area of superficial second degree.

Figure 3. Second-degree burns

A. Second-degree burn with intact blisters.

B. Deep (D), intermediate (I) & superficial (S) second degree burns.

Figure 4. Third-degree burns

A. Third-degree burn before cleaning and debridement of loose, dead skin.

B. Third-degree burn with eschar.

Figure 4. Third-degree burns (Continued)

C. Third-degree burns after cleaning and debridement and escharotomy.

D. Extensive third-degree burns with eschar formation.

FLUID RESUSCITATION

Goal: Over the first 24–48 hours post burn, plasma is lost into the burned and unburned tissues, causing hypovolemic shock (when burn size is >20%). The goal of burn-shock resuscitation is to replace these ongoing losses while avoiding over-resuscitation.

Best: Isotonic crystalloids (e.g., lactated Ringer's, Plasma-Lyte IV [Baxter, http://www.baxter.com/]);

- Start intravenous (IV) or intraosseous (IO) administration IMMEDIATELY.
- IV/IO can be placed through burned skin if necessary.
- NO bolus (unless hypotensive, in which case, bolus only until palpable pulses are restored).
- Initial IV rate 500mL/h; start while completing initial assessment.
- Adults: Measure burn size (TBSA) and multiply by 10. This is now your IV fluid rate. For example, if the burn size is 30%: 30 × 10 = 300. Starting rate is 300mL/h.
  - For patients with weight >80kg, add an extra 100mL/h for each 10kg. For example, for a 100kg patient with 30% burns, the starting rate is 300mL/h + 200mL/h = 500mL/h.
  - If resuscitation is delayed, DO NOT try to "catch up" by giving extra fluids.
  - For children, 3 × TBSA × body weight in kg gives the volume for the first 24 hours. One half is given during the first 8 hours.

Better: Enteral (oral or gastric) intake of electrolyte solution

- Sufficient volume replacement will require "coached" drinking on a schedule using approximately the same amount of fluids that would be given IV/IO (see above).
- Oral resuscitation of patients with burns up to about 30% TBSA is possible (see Hydration side bar below).
- If a nasogastric tube (NGT) is available, it is preferable to resuscitate with infusion of electrolyte solution via NGT (e.g., 300–500mL/h. But watch for nausea/vomiting.

Minimum: Rectal infusion of electrolyte solution**.** Rectal infusion of up to 500mL/h can be supplemented with oral hydration (see Hydration side bar.)

Hydration

Plain water is ineffective for shock resuscitation and can cause hyponatremia. If using oral or rectal fluids, they must be in the form of a premixed or improvised electrolyte solution to reduce this risk.

Examples:

- World Health Organization (WHO) Oral Rehydration Solution (per package instructions or 1L of potable water with 6 level teaspoons sugar, 0.5 level teaspoon salt)
- Mix 1L of D5W solution with 2L of Plasma-Lyte
- Per 1L water: add 8tsp sugar, 0.5tsp salt, 0.5tsp baking soda
- Per quart of Gatorade (Stokely-Van Camp Inc., http://www.gatorade.com/): add 0.25tsp salt, 0.25tsp baking soda (If no baking double the amount of salt in the recipe.)

The principles of hypotensive resuscitation according to TCCC DO NOT apply in the setting of burns (without severe bleeding).

HOWEVER

In the unusual setting of burns associated with noncompressible (e.g., thoracic, abdominal, pelvic) hemorrhage, aggressive fluid resuscitation may result in increased hemorrhage. Balancing the risk of uncontrolled hemorrhage against the risk of worsening burn shock from under-resuscitation should be guided by expert medical advice (in-person or telemedicine). Be prepared for blood transfusion.

MONITORING

Goal: Maintain adequate oxygenation and ventilation, avoid hypotension, trend response to resuscitation. Document blood pressure (BP), heart rate (HR), urine output (UO), mental status, pain, pulse oximetry, and temperature, and record data on a flow sheet (Appendix D).

VITAL SIGNS

- **Best:** Portable monitor providing continuous vital-signs display; capnography if intubated; document vital-signs trends frequently (every 15 minutes initially, then every 30–60 minutes once stable for more than 2 hours).
- **Better:** Capnometry in addition to minimum requirements (if intubated).
- **Minimum:** blood-pressure cuff, stethoscope, pulse oximetry, document vital-signs trends frequently.

URINE OUTPUT

Urine output (UO) is the main indicator of resuscitation adequacy in burn shock.

Goal: Adjust IV (or oral/rectal intake) rate to UO goal of 30–50mL/h. For children, titrate infusion rate for a goal UO 0.5–1 mL/kg/hr.

- **Best:** Place Foley catheter
  - If UO too low, increase IV rate by 25% every 1–2 hours (e.g., if UO = 20mL/h and IV rate =300mL/h, increase IV rate by 0.25 × 300 =75mL/h. New rate is 375mL/h.)
  - If UO too high, decrease IV rate by 25%.
- **Better:** Capture urine in premade or improvised graduated cylinder
  - Collect all spontaneously voided urine and carefully measure; >180mL every 6 hours is adequate for adults.
  - A Nalgene® (Thermo Fisher Scientific Inc., http://www.nalgene.com/) water bottle is an example of an improvised graduated cylinder)
- **Minimum:** Use other measures
  - If unable to measure UO, adjust IV rate to maintain HR less than 140, palpable peripheral pulses, good capillary refill, intact mental status.
  - Measure the BP and consider treating hypotension, but remember: BP does not decrease until relatively late in burn shock, because of catecholamine release. On the other hand, BP may be inaccurate (artificially low) in burned extremities.

NOTE: Electric injury

- Patients with high-voltage electric injury causing muscle damage and gross pigment in the urine (and similar patients, such as rhabdomyolysis or crush injury) have a higher target UO of 70–100mL/h in adults. See PFC Crush CPG.
- If this does not cause gradual clearing of the pigment (urine turns lighter on three or four hourly checks), the patient likely needs urgent surgery for decompression/debridement

EXTREMITY BURNS

Burned extremities are vulnerable to injury from post burn swelling.

Goal: Prevent and manage swelling (edema) of burned extremities to prevent long-term damage.

- **Best:** Elevate burned extremities above heart level. Encourage patient to exercise burned extremities to decrease edema. Monitor peripheral pulses on all burned extremities hourly, using a Doppler flowmeter if available. If the peripheral pulses are diminished or absent and evacuation will be delayed, perform escharotomies of circumferential burns to restore blood flow (Appendix A). Be prepared to stop bleeding with combat gauze, electrocautery, or tourniquet as needed. Anticipate blood loss and prepare for blood transfusion.

Obtain teleconsultation.

- **Better:** Consider doing escharotomies for circumferential full thickness (3rd degree) burns of an extremity if extremity is edematous, you are unable to palpate distal pulses, and evacuation will be delayed. Anticipate blood loss and prepare for blood transfusion.

Obtain teleconsultation.

- **Minimum:** Triage patient to more rapid evacuation if extremity is edematous and you are unable to palpate distal pulses. Elevate burned extremities above heart level and have patient exercise or provide passive range of motion (PROM) to burned extremities to mobilize edema. Provide pain control to enable PROM.

PAIN MANAGEMENT

Refer to Analgesia and Sedation Management CPG for Prolonged Field Care.

Burns can be painful and can cause hypovolemia. Thus, frequent, smaller doses of an IV opioid or ketamine are preferred.

- In hypovolemic burn patients, ketamine can be used for severe pain or for painful procedures, but less than the full anesthetic dose is safer (e.g., 0.1–0.2mg/kg IV push, assess response and redose ketamine as needed every 5–10 minutes).
- For prolonged care of burn patients, a ketamine infusion may provide more consistent analgesia and help conserve supplies of analgesic medications.
- Burn wound care is extremely painful. Ensure an adequate supply of analgesic agents is available before starting wound cleaning, debridement, escharotomy, or dressing change. Refer to Analgesia and Sedation CPG or obtain telemedicine advice for adequate dosing of procedural analgesia for burn care.
- Consider administering an oral or IV benzodiazepine for anxiety (common with repeated painful wound care).

INFECTION

Burn wounds are easily infected.

Goal: Prevent burn wound infection through wound care. If evacuation to higher level of care is anticipated within 24 hours, simply cover burns with clean, dry gauze and leave intact blisters in place. Always avoid wet dressings, because of the risk of hypothermia. If evacuation is not anticipated for more than 24 hours, and time, medication, and human resources permit, provide wound care as soon as possible after the injury (within the first 24 hours). If resources are not available initially, provide wound care as soon as possible.

- **Best**: Clean wounds and debride loose dead skin by scrubbing gently with gauze and chlorhexidine gluconate solution (e.g., Hibiclens, Mölnylcke Health Care, http://www.hibiclens.com/) in clean water; apply topical antimicrobial cream (silver sulfadiazine [Silvadene, Pfizer Inc., http://www.pfizer.com/] or mafenide acetate [Sulfamylon, Mylan, http://www.mylan.com/]), followed by gauze dressing. Repeat daily.

  Alternative: instead of cream, use silver nylon dressing (Silverlon, Argentum Medical, http://www.silverlon.com/), covered by gauze dressing.

  - Silverlon can be left in place for 3–5 days as long as the wound is clean when the Silverlon is applied.

- The outer gauze dressings (e.g., Kerlix [Covidien]) should be moistened (not soaked) at least daily. Use sterile (or at least clean, uncontaminated) water or normal saline.
- The outer gauze dressings should be changed, leaving the Silverlon in place, sooner than 3 days if they become saturated with exudate or otherwise dirty.
- If the patient develops any evidence of infection, the Silverlon must be removed and the wound inspected sooner than 3–5 days.
- The Silverlon can be removed and cleaned in sterile, or at least clean uncontaminated, water and reused for up to 5 days.

- **Better:** Clean wounds and debride loose dead skin by washing with any antibacterial soap in clean water, dress wounds with any available dressings; optimize wound and patient hygiene to the extent possible given environment.
- **Minimum:** Cover with clean sheet or dry gauze. Leave blisters intact. Avoid wet dressings.

ANTIBIOTICS

- IV or oral antibiotics are not normally used for prophylaxis in burn patients in the absence of other open wounds requiring them (e.g., open fractures.)
- After several days, if patient develops cellulitis (spreading erythema around edges of burn), treat for gram-positive organisms, (e.g., cefazolin or clindamycin).
- If patient develops invasive burn wound infection (signs: sepsis/septic shock, changes in color of wound, possible foul smell of wound), treat with broad-spectrum antibiotics to include gram-positive and gram-negative coverage that ideally includes coverage for Pseudomonas aeruginosa (e.g., ertapenem + ciprofloxacin).

Fluid and equipment planning considerations. See Appendix E.

Summary Table. See Appendix F.

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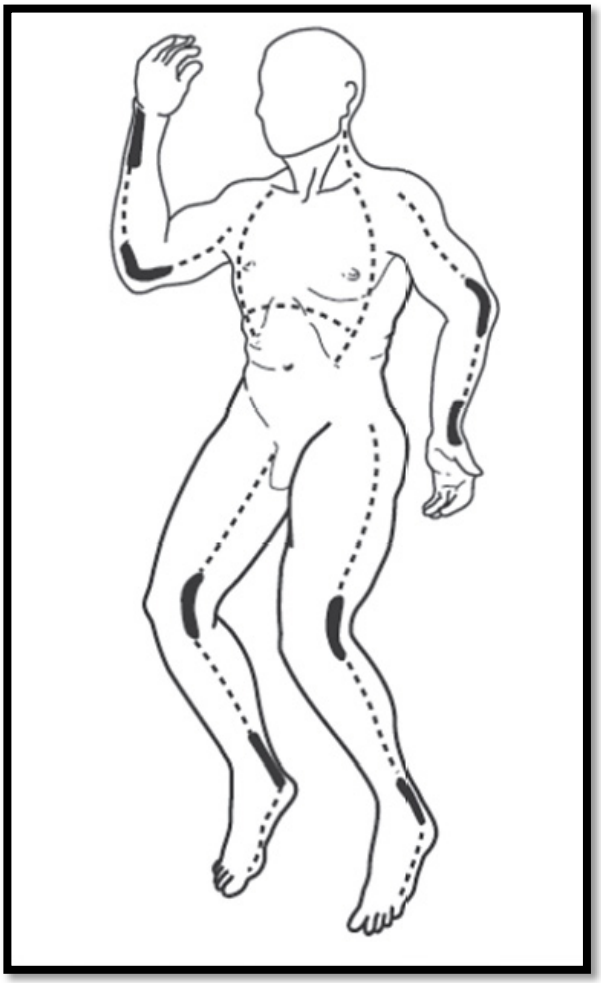
APPENDIX A: ESCHAROTOMY INCISIONS



The incisions on the extremities are placed along the mid-medial and/ or mid-lateral joint lines. The bold lines indicate the importance of always carrying the incisions across any involved joints. The incisions on the chest are intended to free up a mobile "plate" of tissue to restore adequate chest movement with breathing.

Source: Figure 26.1, p. 379, Chapter 26 (Burns). In: Anonymous, *Emergency War Surgery, 4th United States Revision*. Fort Sam Houston, TX: Office of the Surgeon General, Borden Institute, 2013.

Figure A1. Photograph of a patient undergoing escharotomy of the leg, using electrocautery. The goal is to go through the burned skin into viable tissue (i.e., subcutaneous fat).

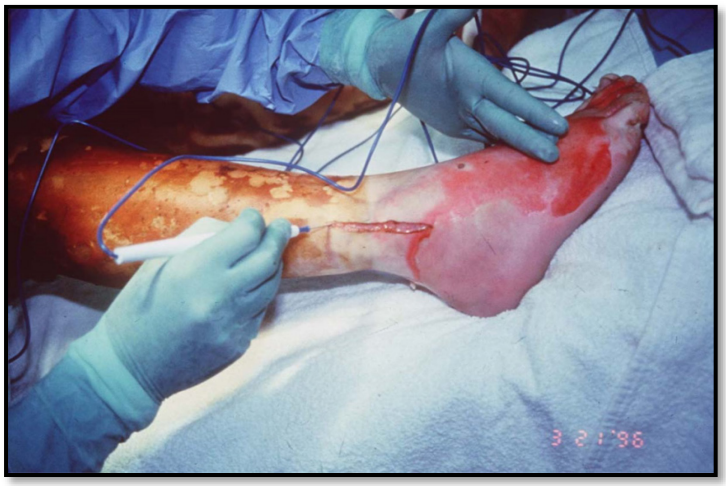
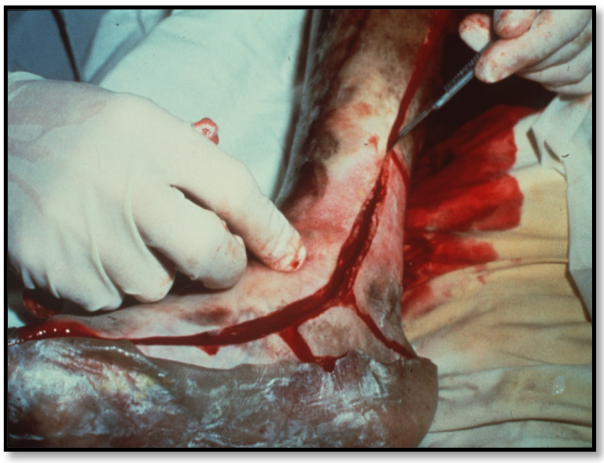
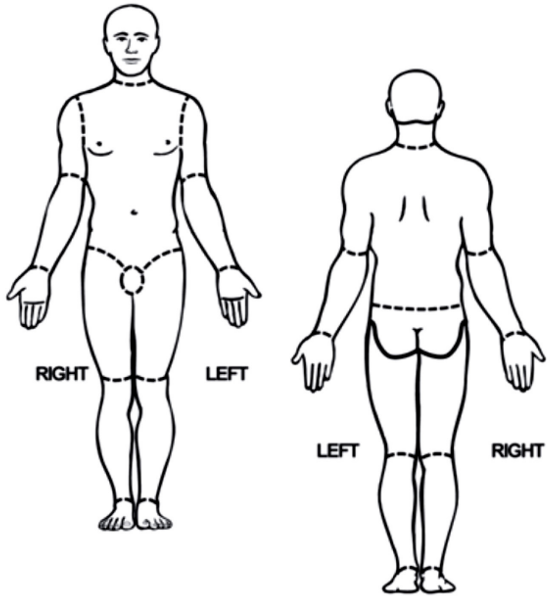


Figure A2. Photograph of a patient undergoing escharotomy of the leg and foot, using a scalpel. When using a scalpel, there may be increased blood loss compared to electrocautery, as shown here.



APPENDIX B: LUND & BROWDER BURN WOUND CALCULATION WORKSHEET

AREA	Birth – 1 year	1 - 4 years	5 - 9 years	10 - 14 years	15 years	ADULT	2nd Degree	3rd Degree	TOTAL
Head	19	17	13	11	9	7			
Neck	2	2	2	2	2	2			
Ant. Trunk	13	13	13	13	13	13			
Post. Trunk	13	13	13	13	13	13			
R. Buttock	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2			
L. Buttock	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2			
Genitalia	1	1	1	1	1	1			
R.U. Arm	4	4	4	4	4	4			
L.U. Arm	4	4	4	4	4	4			
R.L. Arm	3	3	3	3	3	3			
L.L. Arm	3	3	3	3	3	3			
R. Hand	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2			
L. Hand	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2	2-1/2			
R. Thigh	5-1/2	6-1/2	8	8-1/2	9	9-1/2			
L. Thigh	5-1/2	6-1/2	8	8-1/2	9	9-1/2			
R. Leg	5	5	5-1/2	6	6-1/2	7			
L. Leg	5	5	5-1/2	6	6-1/2	7			
R. Foot	3-1/2	3-1/2	3-1/2	3-1/2	3-1/2	3-1/2			
L. Foot	3-1/2	3-1/2	3-1/2	3-1/2	3-1/2	3-1/2			
						Total			



BURN DIAGRAM

Age _____

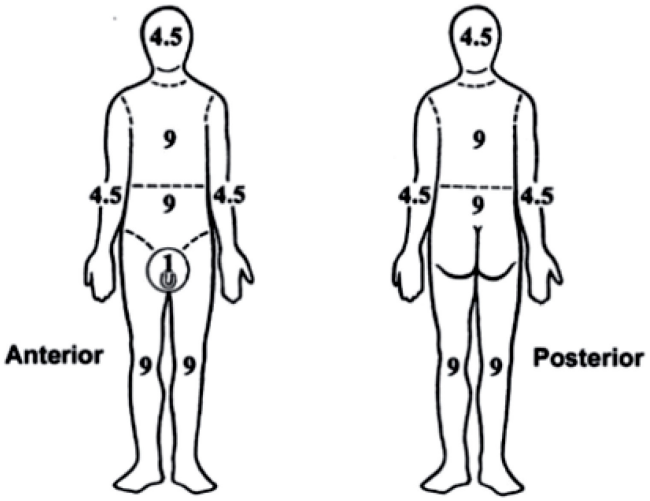
Sex _____

Date of Burn _____

ISR Staff MD _____

COLOR CODE
Blue = 2nd Degree
Red = 3rd Degree

APPENDIX C: RULE OF NINES BURN WOUND CALCULATION



Use this image to calculate the percent of total body surface area (%TBSA) involved by second and third degree burn wounds (do NOT include first degree wounds in this assessment). Example: Second and third degree wounds involving the entire anterior torso and right upper extremity, front and back, would be cover 27% TBSA. If this wound had scattered areas of unburned skin and/or first degree burns, adjust the %TBSA downward. %TBSA is an estimate. Both over- and underestimates have potential negative impacts on a patient's resuscitation.

APPENDIX D: JOINT TRAUMA SYSTEM (JTS) BURN RESUSCITATION FLOW SHEET

Date		Initial Treatment Facility				
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary
Date & Time of Injury				BAMC/ISR Burn Team DSN 312-429-2876: Yes No		

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8 mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	1st								
	2nd								
	3rd								
	4th								
	5th								
	6th								
	7th								
	8th								
	9th								
	10th								
	11th								
	12th								
	13th								
	14th								
	15th								
	16th								
	17th								
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	20th								
	21st								
	22nd								
	23rd								
	24th								
	25th								
	26th								
	27th								
	28th								
	29th								
	30th								
	31st								
	32nd								

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8 mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	33rd								
	34th								
	35th								
	36th								
	37th								
	38th								
	39th								
	40th								
	41st								
	42nd								
	43rd								
	44th								
	45th								
	46th								
	47th								
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	54th								
	55th								
	56th								
	57th								
	58th								
	59th								
	60th								
	61st								
	62nd								
	63rd								
	64th								
	65th								
	66th								
	67th								
	68th								
	69th								
	70th								
	71st								
	72nd								
Total Fluids:									

APPENDIX E: FLUID & EQUIPMENT PLANNING CONSIDERATIONS

Assumptions: One patient with a 50% total body surface area (TBSA) burn, weighing 80kg, and requiring 4mL/kg/%TBSA for resuscitation the first day (16L), half that the second day (8L), and half that the third day (4L).
Note: For planning purposes only, the Parkland formula of 4mL/kg/%TBSA provides an estimate for the first 24-hour fluid requirements; however, hourly fluid resuscitation should start with the rule of 10s.

Best:

- Fluids: IV fluid (lactated Ringer's solution or Plasma-Lyte) to provide resuscitation for 72 hours (28L)
- Equipment: Portable monitor with capnography; lab capability for serum electrolytes, arterial blood gases, and lactate; Foley catheter with graduated collection system; portable ventilator; portable suction; electrocautery or scapel; oxygen or oxygen concentrator; airway management kit to include endotracheal suction catheter
- Medications: pain medications (refer to *Analgesia, Sedation* CPG)
- Burn-specific dressings: Hibiclens to clean wounds, Silvadene and/or Sulfamylon cream (two 400g jars per patient per day), or silver nylon (Silverlon) dressings
- Nonspecific dressings: roller gauze, torso dressings, tape or stapler
- Hypothermia prevention: sleeping bag or Hypothermia Prevention & Management Kit (HPMK)
- Monitoring: Portable monitor providing continuous vital-signs display; capnography, if intubated; document vital-signs trends, intake and output, GCS, and pain level on a regular basis; burn-resuscitation flow sheet
- Push-pack capability: prepackaged additional 24-hour supplies of fluids, dressings for scenarios >24 hours or >1 patient

Communications: real-time video telemedicine consultation

Better:

- Fluids: IV fluid (lactated Ringer's solution or Plasma-Lyte) to provide resuscitation for 24 hours (16L); oral electrolyte replacement
- Equipment: Blood pressure cuff, stethoscope, pulse oximeter, capnometer, portable ventilator, oxygen or oxygen concentrator, airway management kit to include endotracheal suction catheter
- Graduated container to monitor urine output
- Pain medications
- Nonspecific dressings: roller gauze, torso dressings, tape or stapler
- Hypothermia prevention: sleeping bag/HPMK/ Blizzard Blanket (Blizzard Protection Systems Ltd., http://www.blizzardsurvival.com/)
- Monitoring: Frequent vital signs, examination, fluid input, urine output, flowsheet to document

Communications: telephone; e-mail digital photos

Minimum:

- Fluids: Resuscitation with commercial or improvised electrolyte solution (oral, enteral, rectal)
- Equipment: Blood pressure cuff, stethoscope, pulse oximeter, bag-valve mask with positive end-expiratory pressure (PEEP) valve, airway management kit
- Graduated or improvised graduated container to monitor urine output
- Pain medications
- Clean sheet, any available trauma dressings
- Hypothermia prevention: sleeping bag/emergency blanket/blankets
- Monitoring: Frequent vital signs, examination, fluid input, urine output documented on preprinted or improvised flowsheet

Communications: Telephone.

APPENDIX F: SUMMARY TABLE

Airway	
Best	• Rapid Sequence Intubation • Continuous sedation + airway maintenance and suctioning • O_2 and portable ventilator
Better	• Cricothyroidotomy • Continuous sedation + airway suctioning • O_2 concentrator and portable ventilator
Minimum	• Cricothyroidotomy • Ketamine • Bag-valve-mask with PEEP valve
Assess Burn Size	
Best	• For initial estimate: Rule of 9s • After wounds are cleaned/debrided: re-calculate burn size using Lund-Browder chart
Better	• Same as minimum
Minimum	• For large burns: Rule of 9s • For small burns: Use patient's hand = 1% TBSA
Fluid Resuscitation	
Best	• Use isotonic crystalloid: Lactated Ringer's (LR) or Plasma-Lyte • Starting fluid rate is rule of 10s (TBSA x 10; +100 ml/hr for each 10 kg over 80 kg)
Better	• Oral resuscitation with electrolyte solution (avoid plain water) • Possible for up to 30% TBSA burns • "Coached" drinking on a schedule to meet target fluid rate
Minimum	• Rectal infusion of electrolyte solution • Can infuse up to 500 ml/hr • May use to supplement oral hydration
Teleconsultation	
• Establish contact early • Ventilator management • Measuring burn size • Hemorragic shock + burns	• Burn > 20% TBSA • Electrical burn • Escharotomy needed • Infection
Monitoring	
Vital Signs	
Best	• Portable monitor • Capnography • Document vital signs (VS) and I/O on flow sheet
Better	• BP cuff, stethoscope • Pulse oximetry, Capnography • Document VS and I/O on flow sheet
Minimum	• Blood Pressure (BP) cuff, stethoscope • Pulse oximetry • Document VS on flow sheet
Urine Output	
Best	• Foley catheter, titrate fluids to keep urine output (UO) 30-50 ml/hr • Increase or decrease fluid rate by 25% each hour if UO not at goal
Better	• Collect urine in graduated container • >180 ml every 6 hours is adequate
Minimum	• If unable to measure UOP, adjust fluids to maintain HR <140, good capillary refill, intact mental status • Treat hypotension if needed, but this is a late sign of hypovolemia

Extremity Burns	
Best	• Elevate, Exercise • Monitor pulses hourly, Doppler flow meter • Escharotomy if circumferential 3rd degree burn
Better	• Elevate, Exercise • Monitor pulses hourly • Escharotomy only if unable to palpate distal pulses and evacuation delayed
Minimum	• Elevate, Exercise • Monitor pulses hourly
Pain Management	
Best	• Ketamine infusion • Supplement with IV opioids and midazolam (e.g., Versed), frequent small doses
Better	• Ketamine IV • Supplement with IV opioids and midazolam, frequent small doses
Minimum	• Fentanyl Lozenge • Oral acetaminophen/oxycodone (e.g. Percocet, Endo Pharmaceuticals, http://www.endo.com/)
Infection	
Prevent Infection	
Best	• Clean wound and debride loose dead skin using gauze and Hibiclens in clean water • Apply antimicrobial cream (Silvadene or Sulfamylon), cover with gauze. • Alternative: Apply Silverlon dressings to clean wounds, cover with gauze
Better	• Clean wound and debride loose dead skin using any antibacterial soap in clean water • Apply any available dressing • Optimize wound care and hygiene to extent possible
Minimum	• Cover with clean sheet or dry gauze • Leave blisters intact
Treat Infection	
Best	• If cellulitis (spreading erythema around edge of burn) treat with IV antibiotics (e.g., cefazolin or clindamycin) • If invasive infection with sepsis, foul smell, or burn wound color change, cover gram-positive and gram-negative and Pseudomonas bacteria (e.g. ertapenem + ciprofloxacin)
Better	• Same as minimum
Minimum	• If cellulitis (spreading erythema around edge of burn) or invasive infection, treat with antibiotics. • Any available antibiotic

APPENDIX G: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Catastrophic Non-Survivable Brain Injury (CPG ID: 13)

Useful guidelines to manage casualties with catastrophic, non-survivable brain injury at Role 2 and Role 3 facilities.

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BACKGROUND

Catastrophic brain injury, for the purpose of this guideline, is defined as any brain injury that is expected after imaging evaluation and /or clinical exam to result in the permanent loss of all brain function above the brain stem level.

NOTE: For patients with potentially survivable but severe Traumatic Brain Injury (TBI), refer to Joint Trauma System CPG, *Neurosurgery and Severe Head Injury, 02 Mar 2017*.

1. The intent of this guideline is to provide clinically useful recommendations which will allow providers at all roles of care who encounter these injuries to optimize the opportunity for these casualties to be evacuated safely and appropriately to the next level of care.

2. It is not the purpose of this guideline to address the complexities of brain death determination, or at what role of care and by what types of providers this determination should be made.

3. If appropriately resuscitated and hemodynamically normalized, these patients are more likely to be re-united with their families at Role 4 facilities. Additionally, evacuation from a combat theater of operations preserves the potential to honor the expressed intent of a patient to participate as an organ donor. Experience at Landstuhl Regional Medical Center between 2003 and 2013 demonstrated this opportunity to be on par with higher performing centers in CONUS. (Publication in draft, J. Oh, personal communication, 05 Aug 2016)

Catastrophic brain injury is associated with profound physiologic alterations that result in diffuse vascular regulatory disturbances and widespread cellular injury.[1, 2] Severe alterations in metabolism,[3-5] endocrine function,[6-9] immunology[10] and coagulopathy[11-17] also commonly manifest. These disturbances frequently lead to multiorgan system failure, cardiovascular collapse and asystole in up to 60% of patients if not appropriately managed.[3]

It is known from animal studies that this cardiovascular deterioration is associated with impaired oxygen utilization, a shift from aerobic to anaerobic metabolism, a depletion of glycogen and myocardial high-energy stores, and the accumulation of lactate.[3,5,9] This irregular metabolism has been associated with low levels of triiodothyronine (T3), thyroxin (T4), and to a lesser extent cortisol and insulin.[6-9] Therapeutic replacement with T3 has been associated with complete reversal of anaerobic metabolism and subsequent stabilization of cardiac function when applied to human brain dead subjects.[6,7] In addition, the use of T3 and similar thyroid replacement preparations have been associated with significant improvements in cardiovascular status, reductions in inotropic support, and decreases in donors lost from cardiac instability.[5, 18-20] The etiology of this functional “hypothyroid state” is poorly understood, but may be a result of lower than normal thyroid stimulating hormone levels caused by the irreversible damage to the hypothalamus and pituitary from ischemia.[21] Another explanation is a decrease in the peripheral conversion of T4 to its more potent analogue T3, similar to the euthyroid sick syndrome. It should be noted that evidence which validates the efficacy of hormonal replacement in this population of patients is not conclusive.[22, 23] While this subject matter continues to be evaluated it should be recognized that early, effective, conventional critical care management is the therapeutic mainstay in these patients.[24]

TREATMENT

The clinical management of catastrophic brain injury is focused on hemodynamic stabilization. This consists of three aspects:

1. Early identification of the severity of injury, as severity of the TBI correlates with deficiencies in the pituitary adrenal axis, leading to hemodynamic instability.[25]
2. Intensive care management to achieve hemodynamic stability based on degree of TBI and associated injuries.[26]
3. Resuscitation with fluids and blood products, early use of vasopressors and consideration for endocrine/hormone therapy in patients with refractory hemodynamic instability.

Vasopressors such as norepinephrine should be utilized if the mean arterial pressure (MAP) remains less than 70 mmHg despite adequate fluid resuscitation. (See Appendix A.) In patients whom Diabetes Insipidus (DI) is suspected, consider adding a vasopressin drip to norepinephrine after initial treatment with DDAVP. (See Appendix A and Appendix B treatment of DI). In casualties with catastrophic head injury who require more than a single vasopressor to maintain a systolic blood pressure of 100 mmHg or have evidence of DI, strong consideration should be given for addressing the endocrine abnormalities associated with these injuries that can contribute to ongoing hemodynamic instability. (See Appendix B.)[25-29] Adjuncts shown to assist with hemodynamic stability include stress dose steroids, IV insulin, and replacement of thyroid hormone.

These adjuncts are:

1. 1 ampule 50% dextrose IV
2. 2 g solumedrol IV
3. 20 units regular insulin IV
4. 20 micrograms of thyroid hormone (T4) IV, if available

This is given as an initial bolus followed by a continuous infusion of 10 mcg/hr of T4, if it is available.

An appropriately aggressive approach should also stress early identification and management of catastrophic brain injury-related complications such as:

1. Disseminated intravascular coagulation (DIC)
2. Diabetes Insipidus (DI)
3. Neurogenic pulmonary edema (NPE)
4. Hypothermia
5. Cardiac arrhythmias

See Appendix C for management points on each.

TRANSFUSIONS CONSIDERATIONS

The use of blood products for these patients is a complex issue involving the proper use of limited resources in theater and the paucity of evidence-based recommendations on this topic. If the patient responds hemodynamically to the previous interventions and appears stable after the initial insult, a reasonably aggressive approach should be taken to correct coagulopathy rapidly and transfuse PRBCs to a level sufficient to optimize oxygen delivery to tissue and organs. There is little to support optimal hemoglobin in this population, but in general critically ill populations, a target above at least 7g/dL has been recommended.[30] In this patient population, however, goal hemoglobin of 10g/dl has been set for this protocol. (See Appendix A.) Other blood products are used as per standard ICU practice to correct pre-existing traumatic coagulopathy or disseminated intravascular coagulation generated by the release of tissue factor from necrotic brain tissue. An International Normalized Ration (INR)<1.5 and platelet count >50,000 should be considered until evacuation occurs.[31]

DETERMINING FUTILITY AND THE APPROPRIATENESS OF TRANSPORT

RESPONSIVE

Within the context of a catastrophic, non-survivable brain injury, if the patient responds to initial resuscitation and treatment and achieves clinical stability, transport to the next higher role of care should be considered. In these circumstances, aggressive effort should be made to re-unite the service member with family at the Role 4 facility. As a secondary priority to be considered only in these otherwise futile situations, service members may also be evaluated for potential organ donation at the Role 4 facility.

NON RESPONSIVE

Within the context of a catastrophic, non-survivable brain injury, if the patient does not respond to initial aggressive resuscitation, continued further efforts should be guided by a combination of clinical judgment and battlefield effects, including: resources available at the current role of care facility (critical care personnel, equipment, and supply resources), other critically injured patients requiring immediate attention, potential for further casualties from active troop contact, and availability and capacity of evacuation to next higher role of care.

The medical evacuation clinical and operational leadership should be engaged early in these circumstances. Clinical discussion and decisions regarding stability for transport should occur between the trauma team and the flight team. The clinical team should also inform medical operations leadership who will be able to provide information about evolving battlefield effects affecting the availability and capacity of transport.

If the patient cannot be clinically stabilized or battlefield effects otherwise preclude transport, no further efforts should be pursued and withdrawal of support with dignity and with comfort measures is the most respectful and appropriate course of action. Providers presented with these patients are always encouraged to discuss patient care with colleagues and medical leadership at their location to achieve a clinical consensus in these very difficult situations. When available and appropriate, they are also encouraged to communicate with trauma providers at the next higher role of care to achieve consensus on the plan to transport or not to transport. These situations are fortunately not common, but constitute the most challenging of clinical and ethical management dilemmas that one can face while deployed.

PERFORMANCE IMPROVEMENT MEASURES

POPULATION OF INTEREST

All patients with traumatic brain injury with head AIS > 3 and Role 3 or Role 4 discharge GCS=3 and death within 30 days.

INTENT (EXPECTED OUTCOMES)

1. Safely evacuate patients in the population of interest to Role 4.
2. Patients with catastrophic brain injury receive medical management according to the CPG.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have a documented neurosurgery consultation.
2. Number and percentage of patients diagnosed with brain death at Role 4 who are organ donors.

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for Performance Improvement (PI) monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed. The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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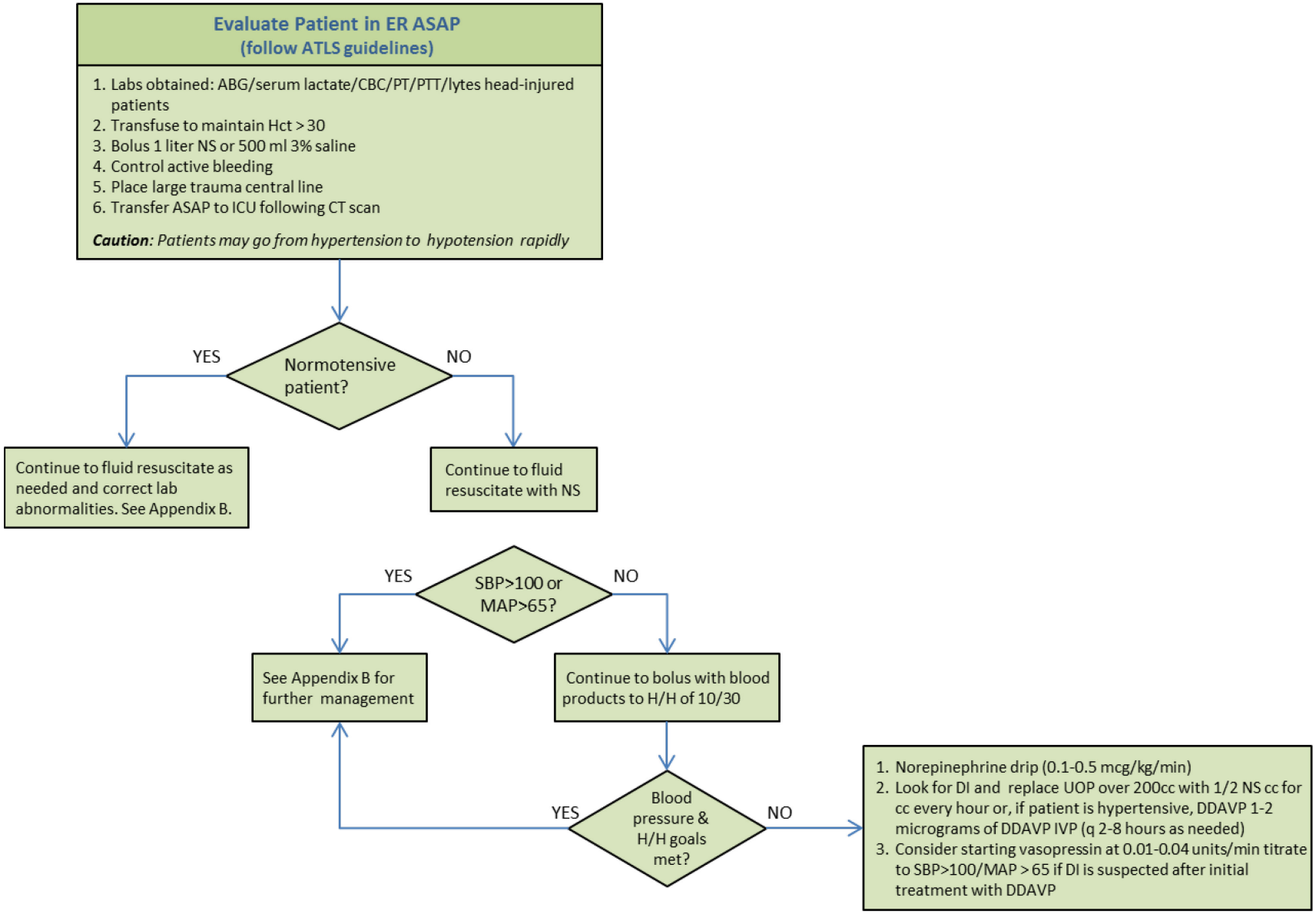
APPENDIX A: CATASTROPHIC BRAIN INJURY RESUSCITATION MANAGEMENT FOR PERSISTENT HYPOTENSION


Evaluate Patient in ER ASAP
(follow ATLS guidelines)
1. Labs obtained: ABG/serum lactate/CBC/PT/PTT/lytes head-injured patients
2. Transfuse to maintain Hct > 30
3. Bolus 1 liter NS or 500 ml 3% saline
4. Control active bleeding
5. Place large trauma central line
6. Transfer ASAP to ICU following CT scan
Caution: Patients may go from hypertension to hypotension rapidly
Normotensive patient?
YES
NO
Continue to fluid resuscitate as needed and correct lab abnormalities. See Appendix B.
Continue to fluid resuscitate with NS
SBP>100 or MAP>65?
YES
NO
See Appendix B for further management
Continue to bolus with blood products to H/H of 10/30
Blood pressure & H/H goals met?
YES
NO
1. Norepinephrine drip (0.1-0.5 mcg/kg/min)
2. Look for DI and replace UOP over 200cc with 1/2 NS cc for cc every hour or, if patient is hypertensive, DDAVP 1-2 micrograms of DDAVP IVP (q 2-8 hours as needed)
3. Consider starting vasopressin at 0.01-0.04 units/min titrate to SBP>100/MAP > 65 if DI is suspected after initial treatment with DDAVP

APPENDIX B: MANAGEMENT OF CATASTROPHIC BRAIN INJURY

1. Disseminated Intravascular Coagulation (DIC)

Begin correcting any coagulation lab abnormalities (thrombocytopenia, increased INR) early, before clinical DIC.

2. Diabetes Insipidus (DI)

- If patient is normotensive, serum sodium > 150 and Urinary Output (UOP) > 600cc/hr, give 1-2 micrograms of DDAVP IVP (q 2-8 hours as needed)
- Replace UOP cc for cc with 1/2 NS q hour for UOP > 200 (example: for UOP of 1000cc replace with 800cc of 1/2 NS).
- If patient's serum sodium > 150 and UOP > 300cc/hr, replace UOP cc for cc with 1/2 NS q hour for UOP > 200cc.
- If patient is hypotensive, then use protocol in Appendix A, and consider adding a vasopressin drip if DI is suspected.

Pitfalls: Assuming high UOP is from DI, but is really from diuretics and/or Mannitol. Replace diuretic fluid loss with NS or LR if hypotensive. (Another marker of DI: urine specific gravity < 1.005).

3. Tachycardia and Hypertension

This commonly occurs prior to complete herniation and should not be treated. Abrupt fluctuations in blood pressure during the period before and immediately after herniation are common. Aggressive treatment of hypertension will only further exacerbate the hypotension that may follow during the natural physiologic course of the herniation process.

4. Neurogenic Pulmonary Edema

This may occur and results in decreased PaO2; increase ventilator support as needed. With severe problems of oxygenation, utilize increased Positive End Expiratory Pressure (PEEP) and consider advanced ventilator modes such as Airway Pressure Release Ventilation (APRV) or VDR if available. Increasing PEEP, however, can decrease cerebral venous return and should be considered when managing neurogenic pulmonary edema. Similarly, APRV results in permissive hypercapnia, also detrimental to a head injured patient. Once neurogenic edema has been diagnosed, maintaining a low cardiac filling and limiting intravenous fluids to minimize pulmonary edema would be ideal, however, it must be done while balancing of needs of the other organ systems.

5. Hypokalemia and/or Hyperglycemia

Use sliding scales as needed.

6. T4 Protocol

Many patients have a T-3/T-4 deficiency and require additional thyroxin. Start patients on thyroxin protocol if thyroxine is available in patients with severe TBI that are continually hypotensive despite adequate fluid resuscitation and high dose pressors. (Appendix C: T-4 Replacement Protocol) Be aware that potassium will likely need to be aggressively replaced once thyroxin is started.

7. Cardiac Arrest

Follow ACLS code guidelines.

APPENDIX C: T-4 REPLACEMENT PROTOCOL

PRETREATMENT

1. Fluid resuscitate to predefined endpoints (CVP > 7, SBP > 100)
2. Give blood to achieve an H&H above 10 and 30
3. Correct electrolyte imbalances

PREREQUISITE

Patient is requiring a combined vasopressor need greater than 15 mcg (all VP added) to maintain a systolic pressure of 100 after the pre-treatment is completed or becomes hemodynamically unstable.

T-4 PROTOCOL

- Administer IV boluses of the following in rapid succession:
  - 1 Amp of 50% Dextrose
  - 2 gm of Solumedrol
  - 20 units regular insulin
  - 20 mcg Thyroxin (T-4)
- Start a drip of 200 mcg T-4 in 500cc Normal Saline (0.4mcg/cc). Administer at 25cc (10mcg) per hour initially. Reduce levels of other vasopressors as much as possible and then adjust T-4 as necessary to maintain desired pressure.
  - Donors > 100 lbs give above dose
  - Donors 50-75 lbs. give 13cc = 5.2 mcg/hr
  - Donors 75-100 lbs. give 19cc = 7.6 mcg/hr
- After 30 to 60 minutes, patients may become tachycardic with an increase in temperature and blood pressure.

  Monitor K+ levels carefully. The only perceived complication of T-4 identified to this point is an unusually high K+ requirement in some cases.

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Cervical and Thoracolumbar Spine Injury Evaluation, Transport and Surgery in the Deployed Setting

Guidance for providing the best care to patients who suffer a spine or spinal cord injury.

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01 Sep 2023 update: SAVeO2 oxygen parameters

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GOAL

The *Cervical and Thoracolumbar Spine Injury Evaluation, Transport, and Surgery CPG* delivers updated, accurate guidance to the deployed provider in order to afford the best care to patients who suffer a spinal column or spinal cord injury. This requires constant re-evaluation of the literature, both military and civilian, in addition to reviewing the lessons learned from past and present deployments. Review of these sources drives evidenced-based changes in treatment and triage algorithms, while providing updates on injury classification and current mechanisms of injury.

The authors provide key recommendations for each section.[1] It should be noted that while there may be strong evidence in the civilian literature for managing certain aspects of trauma, not all of these recommendations translate into a combat-trauma setting and so the account for the resource restricted environment of the deployed setting.

BACKGROUND

Injury to the spinal column or spinal cord occurs in approximately 5.5% of evacuated battle casualties and are among the most disabling conditions wounded service members face.[2,3] Spine injuries in theater occur through a variety of battle-related and nonbattle related mechanisms.[2,4,5] In a review of the Joint Theater Trauma Registry (now the DoD Trauma Registry) from 2001-2009, Blair reported the characteristics of 598 American service members who sustained spine injuries during Operation Iraqi Freedom and Operation Enduring Freedom.[2] In this population, 502 (84%) patients experienced 1,834 battle-related spine injuries. The remaining 96 (16%) service members sustained 267 nonbattle-related injuries.[2] From a mechanistic perspective, most battle injuries occur from explosions (66.7%) or gunshot wounds (17%) while nonbattle injuries most frequently result from motor vehicle accidents (54%) or falls (30.2%).[2] Additionally, patients with battle related spine injuries have significantly higher Injury Severity Scores (ISS), present more frequently with noncontiguous spinal fractures and are more likely to require operative intervention.[2,5] Despite these differences, the rate and severity of underlying spinal cord injury appears similar between groups. Blair reported an 18.1% incidence of spinal cord injury in patients with battle-related injuries compared to a 13.5% incidence in the nonbattle-related group. Of patients with neurologic deficits, approximately 45% from each group presented with a complete deficit.[2] In a separate review of the same 598 records, Blair reported 66% of injuries occurred due to blunt trauma, while 28% resulted from penetrating injuries and 5% experienced a combined blunt and penetrating mechanism.[4] Patients sustaining penetrating injury were more likely to experience spinal cord injury than those with blunt force mechanisms (38% vs. 10% $p<.0001$).[4]

The timing and location of surgical intervention has also been a point of debate both in civilian and military settings.[6-10] The scarcity of data defining the optimal setting for surgical intervention when the injury occurs in a combat zone adds further challenges. The goal of decompressing and stabilizing the spine/spinal cord injury must be weighed by operational and logistical considerations in addition to the ability of the deployed spine surgeon.

In general, spine trauma patients may be placed into one of 3 clinical categories:

1. Patients with complete spinal cord injury.
2. Patients with an incomplete spinal cord injury
3. Patients with a spine fracture but normal neurological function.

In regards to the timing of surgery, an incomplete injury from a non-penetrating mechanism is often the most challenging in the decision-making process as these patients are the ones most likely to benefit from early surgical intervention in terms of neurological recovery.[5,9]

CLINICAL & RADIOGRAPHIC EVALUATION

KEY RECOMMENDATIONS

1. Document the patient's neurologic status via the American Spinal Injury Association (ASIA) Examination. Alternatively, the Combat Neuro Exam can be used. (**Level III**)

2. Computerized tomography (CT) is the recommended means to radiographically assess for bony spinal injuries. (**Level I**)

3. Plain films can be used to radiographically assess the bony spine if CT is not reasonably available, but caution should be used in removing cervical stabilization without CT imaging. (**Level III**)

4. CT Angiography (CTA) is recommended for any patient with a suspected craniocervical vascular injury. (**Level II**)

5. Given the limited availability of MRI at echelons lower than Role 4, CT myelography may assist in the evaluation and workup of patients with spinal cord injuries in theater if the required resources are available. (**Level III**)

6. Cervical collars should be placed on all patients with symptoms correlating to a cervical spine injury or in accordance with the Canadian C-spine Rule. (**Level III**)

7. Clearance of a C-spine can be done via a clinical exam, radiographic studies, or a combination of the two depending on the neurological status of the patient. Document the clearance of the C-spine (**Level II**)

NEUROLOGIC EXAM

Every effort must be made to document an accurate and thorough neurological examination, especially when surgery or aeromedical transport is planned. The quality of the examination can be degraded by patient's mental status, effort and degree of cooperation, medication effect including sedatives, the presence of an airway adjunct or endotracheal tube, or the presence of other injuries. Failure to perform and document a neurological exam has been the most common source of discrepancy between serial neurological examination findings, especially between levels of care.

A thorough neurologic exam should include:

- Motor exam of the 10 ASIA key motor groups (Appendix A).
- Sensory examination (pin prick and light touch) using ASIA dermatomal standards.
- Digital rectal exam that assesses voluntary anal sphincter contraction strength, pinprick sensation, resting tone and bulbocavernosus reflex (BCR).

- Normal and pathological reflex testing such as biceps, triceps, brachioradialis, knee, and ankle jerk responses as well as presence/absence of Babinski reflex and Hoffman's signs, or evidence of spinal cord injury patterns, including Central Cord Syndrome, Brown-Sequard Syndrome, etc.

In patients with suspected spinal column injury, with or without neurologic deficit upon presentation, frequent repetition and surveillance of the neurologic examination (focusing upon motor and sensory performance) is imperative. It is recommended to use Appendix A: ASIA Worksheet and attach to the patient's chart.

Alternatively, the *Combat Neuro Exam* is a simpler documentation tool than the *ASIA Worksheet* and may be more amenable to non-spine specialists to complete. (See Appendix B: Combat Neuro Exam.) This note addresses the minimal elements of a complete neurological exam for a patient with significant spinal column injury. Fill out and attach to the patient's chart.

RADIOGRAPHIC ASSESSMENT

In the assessment of the patient with possible spinal injury, plain radiography has been superseded by axial CT with sagittal and coronal reconstruction where available.[11] If CT is not available and evacuation to a higher level of care will not occur in a timely fashion, then plain radiographs will suffice for clinical decision.

Often, polytrauma patients will undergo a protocoled study involving a CT angiography of the neck, with follow-through of the chest, abdomen and pelvis, which adequately assesses the entire spinal axis for osseous as well as craniocervical vascular compromise. For less severely injured patients not warranting such a study, clinical suspicion should guide the decision to obtain imaging. A low threshold to obtain a CTA should be maintained, particularly in those with a documented cervical spinal fracture, or positive screening criteria for blunt cerebrovascular injury (BCVI); see Appendix C: Expanded Screening Criteria for Blunt Cerebrovascular Injury).[12]

In instances of spinal injury with incomplete deficits of the spinal cord, conus medullaris or cauda equina, particularly when those deficits are progressive, consideration should be given to performance of CT myelography (See Appendix D: Adaptation from Omnipaque™ (iohexol) package insert). This would allow for the most rapid diagnosis and potential opportunity for decompression when faced with an incomplete or progressive deficit.

WHEN TO USE A RIGID CERVICAL COLLAR

Patients who have sustained injuries through the following mechanisms should have a rigid cervical collar if available, or some other form of cervical stabilization placed in the prehospital environment if the tactical situation allows:

- Trauma resulting in loss of consciousness or even the question of loss of consciousness due to any form of head injury.
- Trauma resulting in temporary amnesia/loss of consciousness.
- Major explosive or blast injury.
- Mechanism that produces a violent impact on the head, neck, torso or pelvis.

- Mechanism that creates sudden acceleration/deceleration or lateral bending forces on the neck or torso.
- Fall from height (vs. fall from standing).
- Ejection or fall from any motorized vehicle.
- Vehicle rollover.

The Canadian C-Spine Rule was developed to reduce unnecessary imaging of the cervical spine in low risk patients.[13] The Rule was subsequently validated and applied to the prehospital setting.[14]
The Rule comprises the following three main questions:

1. Is there any high-risk factor present that mandates radiography (i.e. age ≥65 years, dangerous mechanism, or paresthesias in extremities)?

2. Is there any low-risk factor present that allows safe assessment of range of motion (i.e., simple rear-end motor vehicle collision, sitting position in ED, ambulatory at any time since injury, delayed onset of neck pain, or absence of midline C-spine tenderness)?

3. Is the patient able to actively rotate neck 45° to the left and right?

When combined, the Canadian C-Spine Rule has a 100% sensitivity for ruling out clinically important cervical injuries.[13] While combat injury mechanisms generally fall within the definition of a "dangerous mechanism" as listed above, dismounted Improvised Explosive Device (IED) blast injuries without associated head trauma have been found to have a low incidence of cervical spine fractures.[14] Thus, it warrants consideration that injured patients without neurologic symptoms, who are ambulatory, and who have full painless range of motion of the cervical spine may not require prehospital cervical collar placement.[14]

Any patient complaining of neck pain or displaying neurological impairment following a trauma should have a cervical stabilization performed and maintained until the cervical spine has been "cleared" by a qualified provider.[15,16] Removal of the collar may be safely performed without further radiographic imaging if the answers to the Canadian C-Spine Rule are "No" to the first question and "Yes to questions 2 and 3.

In general, patients with penetrating cervical injury from an explosive mechanism should have a cervical collar placed if possible. However, patients with isolated penetrating cervical injury who are conscious and have no neurologic signs should not have a cervical collar placed in the prehospital environment. When a blunt mechanism is combined with a penetrating injury, the cervical collar is an important protection until an unstable spinal injury is ruled out. All providers must be aware that the collar may hide other injuries as well as and developing pathology such as expanding hematoma. Patients with isolated penetrating brain injury do not require a cervical stabilization unless the trajectory suggests cervical spine involvement.[17] On the battlefield, preservation of the life of the casualty and medic are of paramount importance. In these circumstances, evacuation to a more secure area takes precedence over spine immobilization.

If a patient has indications for cervical collar placement, and one had not been placed in the prehospital environment for whatever reason, the collar should be placed at the earliest opportunity. unless cervical clearance has been clearly documented in the record or directly communicated to the receiving treatment team, a rigid cervical collar should be placed at each transition in care from downrange and

maintained until it is officially cleared by the receiving providers. This highlights the need for clear and consistent communication along the echelons of care.

CERVICAL SPINE CLEARANCE ALGORITHMS

Any patient with a suspected cervical spine injury and a neurologic deficit should have a cervical collar in place, and should be referred immediately for neurosurgical or orthopedic spine consultation and imaging. All other patients who have indications for prehospital cervical collar placement as detailed above with the Canadian C-Spine Rule should undergo cervical spine clearance by the appropriate algorithm. There are separate algorithms for reliable (Appendix E) and unreliable (Appendix F) patients. Unreliable patients are those who cannot adequately communicate, have a decreased level of consciousness (GCS<15), or have a significant distracting injury. However, controversy exists about the clinical importance of distracting injuries.

Significant distracting injury is technically defined as any injury, which is so painful that it may obscure the patient's ability to notice pain in their neck. The treating physician makes the final determination whether a certain injury is distracting enough to render a patient unreliable and require clearance via the unreliable patient algorithm. The rate of missed injury in the presence of a distracting injury is above 12%, but has not been shown to be significantly higher than in patients without distracting injuries.[18,19] However, if uncertain, err on the side of caution and consider the injury distracting and proceed accordingly. Clearing the C-spine in this scenario requires good communication with the next echelon of care (Appendix G: Cervical Spine Clearance Status) or defer to that level of care for clearance.

See Appendix E and Appendix F for protocol diagrams. If possible, the cervical spine should be cleared and the collar removed within 24 hours of collar placement. If the clinical scenario requires that the collar remain in place more than 24 hours, stiff extrication collars should be replaced with collars designed for long-term immobilization that provide greater padding and decubitus ulcer prevention.

CERVICAL SPINE CLEARANCE IN THE OBTUNDED PATIENT

Cervical spine clearance in the obtunded patient is highly controversial and presents additional challenges to the clinician, especially in the combat environment.[15,17,20] Obtunded patients with a concerning mechanism of injury should undergo CT of the spine with fine cuts and multi-planar reconstructed images (3 mm axial, 3 mm coronal and 2 mm sagittal views). If CT is unavailable or unobtainable, full C-Spine plain radiographs (adequate AP, lateral and odontoid) should be performed.[21] Flexion/extension radiography should not be performed in a patient who cannot be simultaneously examined for the development of neurological signs or symptoms. Ultimately, clearance of the cervical spine in the obtunded patient should be left to clinical decision making of the highest level of care the patient is evacuated to who will be providing their longer term care.

For the obtunded patient with negative imaging, the incidence of significant cervical instability is low. It has generally been accepted that occult ligamentous injury is only cleared through a reliable clinical examination with a cooperative, extubated patient or magnetic resonance imaging (MRI). However, recent literature suggests that a high quality negative CT scan may be enough to remove the cervical collar.[22] This protocol has become the new standard to follow in several high-level acute civilian trauma centers and supports the guideline to forego an MRI as a requirement to clear an obtunded patient, per the *Eastern Association for the Surgery of Trauma Practice Management Guideline*.[22]

"[I]n obtunded adult blunt trauma patients, cervical collars should be removed after a negative high-quality C-spine CT result alone. This recommendation is based on the finding that there is a worst-case 9% cumulative literature incidence of stable injuries and a 91% negative predictive value of no injury, after coupling a negative high-quality C-spine CT result with 1.5-T MRI, upright x-ray series, flexion-extension CT, and/or clinical follow-up. Similarly, there is a best-case 0% cumulative literature incidence of unstable C-spine injuries after negative initial imaging result with a high-quality C-spine CT."

As such, with a high quality CT scan negative for fractures, this method of clearance may be utilized in patients who have arrived at their definitive level of care.

There is risk for significant neck movements in obtunded patients while transiting through the aeromedical evacuation system, so it is recommended that they remain with cervical spine immobilization until arrival at their definitive level of care. The incidence of occipital skin breakdown has decreased with the utilization of collars with greater padding (e.g., Miami-J with Occian back) and increased trauma system awareness of this potential complication.

The clinical decision to definitively clear the cervical spine without exclusion of ligamentous injury by either a reliable clinical examination or a MRI should be left to the level of care providing definitive treatment to the patient. Historically, given the challenges and multiple hand-offs inherent to echeloned care, a "2 out of 3" rule for cervical clearance in the obtunded patient has been Landstuhl Regional Medical Center/Role 4 policy since 2011. This rule requires negative results of 2 of 3 modalities (CT, MRI, clinical exam) prior to removing rigid cervical collars in obtunded patients. Given the low, but non-zero, incidence of significant cervical injury missed on standard 3-plane CT scan, it is recommended that when applying the 2 out of 3 rule, that the obtunded patient be transitioned from the traditional rigid collars to a memory foam enhanced rigid collar if available (i.e. Miami-J with Occian back) until either a reliable clinical examination or MRI can be obtained.[22-25] This method helps to decrease the risk of an occipital decubitus ulcer in those patients with a low likelihood of cervical spine injury who are still in transport and have not yet arrived at their level of definitive care.

Determination of when to image the whole spine (occiput to sacrum) versus selective imaging is based on the mechanism of injury, the physical/neurological exam, as well as the mental status of the patient. Patients who have one identifiable fracture in the spine should have their entire spine imaged. Certain mechanisms of injury, such as a mounted blast, should also warrant imaging of the whole spine.

CERVICAL SPINE CLEARANCE DOCUMENTATION

It is recommended that the JTS Cervical Spine Clearance Status Sheet (Appendix G) or Trauma Resuscitation Record (DD Form 3019) be used for documenting the cervical spine evaluation and clearance status. This comprehensive worksheet includes indications for clearance, exam, imaging studies, and final clearance status. It is intended to bring together all cervical spine information onto one sheet of paper and was designed to improve both the completeness and ease of documentation.

PATIENTS UNABLE TO TRANSFER FROM THEATER

The optimal management of host nationals and others unable to transfer is problematic in the austere environment. The availability to obtain CT or transfer the patient to a facility with CT can make spine evaluation and clearance challenging, with reliance on plain radiographs and physical examination. Sound clinical judgment, remote consultation with a spine surgeon (if available), as well as consultation with theater rules of eligibility are of benefit to decision making.

TRANSPORTING PATIENTS WITH SPINAL INJURIES

KEY RECOMMENDATIONS

1. Use a cervical spine immobilization for transport of patients with cervical spine injuries that have not been previously cleared. (**Level II**)

2. Consider the use of a vacuum spine board when available for the transport of unstable thoracolumbar fractures. (**Level III**)

The recommendations below apply to fixed wing transport of patients, with the following exception being applicable to all mechanisms of transport: The majority of patients with cervical spine injuries should be transported using semi-rigid orthotic such as an Aspen or Miami-J collar (if available).

Clinical scenarios may arise wherein halo immobilization may be suitable. Halo fixation is the most rigid and stable form of external cervical spine fixation.[26] Prior to approving the patient for transport, the team leader must ensure halo removal tools are secured to vest in case there is a need for emergent removal to obtain airway or perform CPR. Additionally, the sending team should educate the transport team how to properly remove the halo if needed. It is not recommended that patients be transported via air or ground in cervical traction as the risk of excessive traction weight transfer associated with vehicular movement, G-forces during takeoff and landing, as well as turbulence can result in further injury.

If the patient has a thoracolumbar fracture that is unstable, then he/she should be transported by the Critical Care Air Transport Team (CCATT) using either a vacuum spine board (VSB) or a standard NATO litter preferably with a memory foam pad to help mitigate pressure sores from Role 2 to Role 3 and beyond if available. Depending on the injury, either of these options can provide sufficient stability to patients with thoracolumbar fractures.[27-29] One small study suggested that pressure ulcer development might be decreased with use of VSB when compared to traditional long spine board.[30]

A thoracolumbosacral orthosis (TLSO) should not be worn during the transport process. This is unnecessary and increases the risk of pressure sores. Prior to transport, the spine surgeon and transportation team should agree upon suitability of VSB versus standard NATO litter. The VSB protocol requires that the VSB be deflated and re-inflated periodically to reduce the risk of pressure sores during the transport process. Logrolling in a VSB without “release of vacuum” does not significantly reduce skin pressure. Additionally, pre-transported skin integrity should be documented and care must be given to padding and pressure reduction maneuvers of the occiput and heels. Once cruising in smooth flight is accomplished, it would be reasonable to release the vacuum until either descent or turbulence is encountered. At a minimum, the VSB pressure should be checked every half hour, smoothed, and re-pressurized every hour, and every two hours the team should release straps and logroll patient (holding patient in appropriate alignment) and provide adequate time for relief of pressure points as part of their normal turning schedule. If the patient is on “spine precautions” due to an unstable cervical or thoracolumbar fracture, the bed should be placed in 30 degree of reverse Trendelenburg if possible. If not on “spine precautions,” then the head of bed should be elevated 30 degrees. During transport, all patients should use the sequential compression devices, which are approved for flight.

MEDICAL MANAGEMENT OF SPINAL CORD INJURIES

KEY RECOMMENDATIONS

1. Avoid hypoxemia (SaO2 <90%) and hypotension (SBP<90) for all spinal cord injuries. (**Level III**)
2. Maintain MAP >85 for all spinal cord injuries, with an emphasis on avoiding hypotension. (**Level III**)
3. Steroids are not indicated in the management of combat spinal cord injuries. (**Level I**)
4. Gabapentinoid medication should be considered early for the treatment of neuropathic pain in patients with spinal cord injuries. (**Level II**)
5. Early mechanical and chemoprophylactic measures against deep venous thrombosis (DVT) should be taken in patients with spine and spinal cord injuries. (**Level II**)

Patients who sustain neurologic compromise should have an invasive arterial line for continuous blood pressure monitoring with a goal MAP of 85-90 mmHg for up to seven days following the injury.[15,31] The evidence supporting this goal is mixed, at best, however it is the opinion of the authors that there is a net benefit to maintaining this goal. Regardless, hypotension (SBP < 90 mmHg) and hypoxemia (SaO2 <90%) must be avoided. Acute management of pulmonary dysfunction following traumatic spinal cord injury improves early survival as complications of pulmonary injury are the leading cause of mortality in traumatic spinal cord injury (SCI), specifically in the cervical spine.[32] Vasopressor therapy (in the euvolemic patient) and/or supplemental oxygen are recommended, when necessary, to achieve these goals.[15] Prior to the use of vasopressors, ensure that hypovolemia is addressed through adequate resuscitation and evaluation and control of any bleeding. Vasopressor use in the hypovolemic patient may contribute to additional ischemic loss in other injured tissues.

GABAPENTINOID & NON-GABAPENTINOID MEDICATIONS

Non-gabapentinoid anticonvulsants (carbamazepine, phenytoin, clonazepam, phenobarbital, valproic acid) are not shown to improve or worsen long-term neurological outcomes from acute spinal cord injury.[33] Early administration of the anticonvulsant gabapentin and pregabalin has been shown to have some improvement of motor recovery, pain intensity, and frequency of autonomic dysreflexia.[34-36] Pregabalin and gabapentin are effective for neuropathic pain, depression, and sleep interference.[36] Early (within 24 hours) administration of enteral gabapentin should be considered for spinal cord injury patients in combat.

OTHER INVESTIGATED THERAPIES

The use of other pharmacologic agents such as riluzole, dantrolene, baclofen, naloxone, tamoxifen, and interventions such as hyperbaric oxygen and nitrous oxide do not have sufficient evidence to make a recommendation for use in combat-related spinal cord injury.

HANDLING

While many spinal fractures require the head of bed to be flat prior to surgical correction or external bracing, the bed can usually be placed in 30 degrees reverse Trendelenberg. Logrolling and sacral off-loading can be safely performed in most cases every 2 hours to prevent skin breakdown and to perform

secondary and tertiary assessments. It is incumbent upon the managing provider to better guide positioning management based upon the specific clinical scenario.

CORTICOSTEROIDS

Although the use of methylprednisolone sodium succinate (MSS) 24-hour infusion remains an option for the treatment of acute spinal cord injury within 8 hours of presentation, its utility in the setting of combat-related blunt or penetrating spinal cord injury is NOT recommended due to the lack of benefit and increased complications.[15,37] The primary reasons are on differences in the mechanism of injury (large caliber high velocity projectiles), geographically different and/or austere environments, and concomitant traumatic injuries sustained in combat. The associated open or contaminated wounds of battle casualties with spine or spinal cord injuries are further complicated with steroid administration. Methylprednisolone administration is NOT recommended for any spinal cord injuries sustained in combat.

DVT PROPHYLAXIS REGIMEN

An aggressive DVT prophylaxis regimen should be established early and maintained beyond the evacuation process. Pneumatic compression devices in conjunction with chemoprophylaxis are established treatment standards. Prophylactic dosing of a subcutaneous low molecular weight heparin (LMWH -- e.g. enoxaparin) or FIXED, low-dose unfractionated heparin (UFH) should be initiated as soon as possible but definitely within 72 hours of injury or repair to reduce the risk of thromboembolic events in the acute period after SCI. Given the potential for increased bleeding events with ADJUSTED-dose UFH, this is not recommended for prophylaxis.[38] Early active or passive mobilization of the patient helps to reduce DVT formation and is frequently cited in support of early surgical fixation, when appropriate. Patients who show clinical signs or symptoms of a DVT should undergo further imaging to confirm the diagnosis. If a DVT is present, treatment should be initiated with therapeutic anticoagulation if approved by the spine surgeon. If full anticoagulation is contraindicated, an IVC filter placement should be considered.

OPERATIVE & NONOPERATIVE TREATMENTS

KEY RECOMMENDATIONS

In cases of incomplete spinal cord injury, spinal decompression should be undertaken as soon as it is safe and feasible to do so, including at Role 3 installations if appropriate support and resources are available in theater. (**Level III**)

Taking into account evacuation time, planned staged operations at Role 3 and 4 facilities are an acceptable option in instances where patients present with incomplete injury or worsening neurologic deficit. (**Level III**)

NON-OPERATIVE TREATMENT

In order to proactively guide treatment and logistical decisions, it is imperative that the deployed surgeon be intimately familiar with the operative and non-operative options in their theatre of operation. The actual materials on hand for non-operative management in the deployed setting may be variable, but generally include C-collars, other orthotic braces, and occasionally, halo devices.

For cervical fracture-dislocations, especially those associated with incomplete injury, closed reduction downrange is recommended. In patients with cervical dislocation and spinal cord injury, CT myelogram may represent an alternative advanced imaging modality prior to proceeding with closed reduction. In the civilian literature, MRI data obtained prior to reduction have not been shown to affect the outcome of the closed reduction, provided the patient is awake, neurologically intact and able to provide a reliable examination.[39] Thus closed reduction of cervical fracture-dislocations, even in the absence of an MRI, may represent another area of possible intervention while in-theater.

OPERATIVE TREATMENT

The decision for operative treatment of U.S. and coalition spine fractures in theater is ultimately left to the deployed surgical team, including the spine surgeon (if available) and the Chief of Trauma. Good clinical judgment is a priority in the care of patients with spine and spinal cord injuries in a deployed setting. Surgery that can be delayed safely until the patient arrives to the Role 4 military treatment facility should be delayed. However, there may be some conditions which may benefit from immediate surgery in-theater, including but not limited to:

- incomplete spinal cord injuries
- open cerebrospinal fluid (CSF) leaks
- expected prolonged delay in transport, or
- where an urgent reduction may improve the degree of "root sparing" in a cervical spinal cord injury.

INCOMPLETE INJURIES

The management of incomplete spinal cord injuries in theater remains controversial due to the potential for higher rates of neurologic improvement with early operative intervention weighed against obvious challenges posed by an austere environment. Initial spinal cord injury or subsequent progression can occur via fracture displacement, bone fragment compression, expanding hematoma, spinal cord edema or infarction. In civilian literature, animal studies have demonstrated that immediate decompression of neural elements is associated with a reduction in neurological sequela.[40-44] Several large investigations have demonstrated significant improvement in neurologic outcomes with early surgical intervention in incomplete spinal cord injuries.[6,10,45,46] This information has led many major U.S. trauma centers to adopt a goal of early surgical decompression in cases of incomplete spinal cord injury. There are some data to suggest that it is not the timing of surgery alone that is the key factor, but the extent of decompression.[47] However, these data must be carefully applied to the deployed setting as forward medicine presents unique challenges not experienced in high volume modern trauma centers. In one investigation examining the outcomes of 50 cases of spinal cord injury treated surgically in theater versus those undergoing delayed care at Landstuhl Regional Medical Center, Schoenfeld demonstrated no differences in neurologic recovery between groups.[9] Patients who were treated with surgery in theater had significantly higher rates of postoperative complications (40% vs. 20%) and had higher rates of additional surgical procedures. Though limited by its relatively low case numbers and retrospective nature, this study may challenge the extrapolation of civilian literature to a deployed setting. Given this conflict in civilian and military literature, deployed spine surgeons should carefully weigh the potential for neurologic recovery with available forward resources in cases of incomplete spinal cord injury. Instances of incomplete neurologic deficit with easily addressed compressive pathology, neurologic progression, delayed evacuation or injuries in coalition partners not eligible for evacuation represent times when operative intervention in theater may provide clear benefit to the patient. In these cases,

implants used in theater should be compatible with systems at higher levels of care in case revision surgery is required.

SPINAL INSTRUMENTATION

The decision to perform spinal stabilization in a deployed setting depends, in part, on the presence and sterility of appropriate implants, comfort level of the operative team and availability of sufficient diagnostic imaging modalities. Advocates for early instrumentation argue that stabilizing these injuries minimizes the need for spinal immobilization, improves pulmonary toilet, lowers the risk of venous thromboembolism and may improve analgesia. Yet, these advantages may not fully translate to the deployed population as over half have concomitant extremity or pelvis fracture and/or significant hemodynamic distress.[48] Deployed surgeons may also consider non-instrumented decompressive procedures in cases with incomplete or progressive neurologic deficit and ongoing canal compromise. These simpler cases often place less strain on the deployed operative team and medical logistical system while requiring less operative time and exposure. This decision for early decompressive surgery with delayed stabilization requires careful direct coordination between spine surgeons at Role 3 and 4 facilities. In Schoenfeld's retrospective review of patients who sustained operative spinal injuries in theater this approach resulted in neurologic improvement in 2 of 3 cases.[9]

PENETRATING SPINE INJURIES

KEY RECOMMENDATIONS

1. Consider early surgery in penetrating spinal cord injury for progressive or incomplete neurological deficits in the setting of continued mass effect upon the spinal cord if surgeon and treatment facility capabilities allow.

2. Patients with concomitant hollow-viscus injuries and penetrating spinal cord injuries should be treated with broad-spectrum anti-microbial coverage for 48 hours to 10 days, depending upon the level of contamination of the injury and control of associated any cerebrospinal fluid leak.

SURGICAL INTERVENTION

Spinal cord injuries from penetrating mechanisms are more likely to produce complete neurologic deficit than those sustained through blunt force.[4,49] With penetrating mechanisms, spinal cord injury can occur through direct damage in the projectile tract or via cavitation injury, whereby shock waves imparted on the tissue surrounding the path of the projectile and rapid changes in pressure damage tissue.[50] The two latter forces can produce severe irrecoverable spinal cord injuries, even in cases where the projectile does not penetrate the spinal canal. In these injuries staged debridement of the wound may be required given the cavitary injury to soft tissue. Surgical indications may include progressive neurological deterioration, incomplete deficit (particularly if a missile or fragment is still within the canal) or the presence of a CSF leak. If surgery is undertaken, good dural closure is paramount with an attempt at "water tight" repair. Anterior and oblique entry to the lumbar and lower thoracic spine are at increased risk of infectious complications due to traversal of hollow viscus organs.[51] In these cases the patient's infectious risk and neurological status are key factors in determining the need for and timing of surgical intervention. There is no evidence from the current conflict to support the concept that a complete SCI from a penetrating mechanism has a significant chance of clinical improvement with surgical intervention.

TREATMENT

In 2010, Klimo et al., led a tri-service literature review of articles on penetrating spinal injury sustained in combat and provided treatment recommendations.[52] Based on this review of both military and civilian literature, they concluded that the role of decompression in promoting neurologic recovery remains ambiguous.[52] For an incomplete injury with continued canal compromise, decompression, if attempted, should ideally occur within 24-48 hours. Additionally, persistent and high-flow CSF-cutaneous and pleural fistulae should be surgically treated. The authors recommended consideration of spinal stabilization at the time of initial surgery in cases with associated instability.[52] Because the unique natural histories of these may render typical blunt injury classification systems less applicable, the treatment of these injuries relies largely on clinical decision making of the operative physician.[5,53] In these situations, surgeons should consider: available resources, expertise of the operative team, infectious risks and the patient's neurological status when determining the need for and timing of operative intervention in theater.

CT scans remain the study of choice for penetrating spinal injuries as MRI is typically not as helpful or available in the deployed setting. Additionally, they can be contraindicated given the ferromagnetic activity of the fragment and bullet material.[54] CT myelogram can be considered in patients with occult or persistent CSF leaks that are not easily localized based on exam or plain CT.

Appropriate antibiotic coverage and duration may often prove controversial. In 2011 the Infectious Disease Society and Surgical Infection Society released a joint guideline for the prevention of infection associated with combat-related injuries.[55] This combined statement recommended Cefazolin 2 gm IV q8hrs for 24-72hrs for penetrating spine injuries without evidence of contamination. Fragments passing through contaminated viscus structures such as the esophagus or colon require extended spectrum intravenous anti-microbial coverage of enteric organisms for longer periods of time. Potential antibiotic regimens include Ancef 2g IV q6-8hrs and Metronidzole 500mg IV q8-12hrs; Cetriaxone 2 g IV q24hrs and Metronidazole 500 mg IV q 8-12hrs. Patients with penicillin or cephalosporin allergies may be treated with Vancomycin 1g IV q12hrs + Ciprofloxacin 400 mg IV q8-12hrs. This working group recommended a minimum antibiotic duration of 5 days or until any CSF leak is closed. Steroids should not be considered as therapy for patients with penetrating spinal cord injuries.[56]

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients at risk of or diagnosed with cervical or thoracic spine injury defined as:

- mechanism of injury explosion, fall, or motor vehicle crash;
- head or neck injury with AIS head or neck > 1;
- diagnosis of fracture of vertebral column with spinal cord injury (806), or spinal cord injury without evidence of spinal bone injury (952); and
- less than 1 day between time of injury and arrival at initial medical treatment facility (MTF).

INTENT (EXPECTED OUTCOMES)

1. Patients in population of interest have documented application of cervical collar or any other method for cervical spine stabilization in the prehospital setting or on MTF arrival.

2. Patients with diagnosis of fracture of vertebral column with spinal cord injury (806), or spinal cord injury without evidence of spinal bone injury (952) have a documented neurologic exam to include GCS and completed *ASIA or Combat Neuro Exam worksheet.*

3. Patients in population of interest have the C-spine clearance status documented on the *JTS C-spine Clearance Status sheet* and *Resuscitation Record (DD Form 3019).*

4. Patients with spinal cord injury and abnormal neurologic exam have an arterial line placed within 24 hours of injury or documentation that not indicated.

5. Patient in population of interest who have an unreliable exam due to decreased level of consciousness (GCS < 14) do not have C-spine cleared prior to arrival at definitive level of care.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in population of interest with documented application of cervical collar or any other method for cervical spine stabilization in the prehospital setting or on MTF arrival.

2. Number and percentage of patients with diagnosis of fracture of vertebral column with spinal cord injury (806), or spinal cord injury without evidence of spinal bone injury (952) with documented neurologic exam to include GCS completed *ASIA or Combat Neuro Exam worksheet*.

3. Number and percentage of patients in population of interest with C-spine clearance status documented on the *C-spine Clearance Status sheet* and *Resuscitation Record (DD Form 3019).*

4. Number and percentage of patients with spinal cord injury and abnormal neurologic exam who have an arterial line placed within 24 hours of injury or documentation that not indicated.

5. Number and percentage of patients in population of interest with Role 2 and/or Role 3 discharge GCS < 14 who have a C-collar in place on arrival to Role 3 for host nation patients or Role 4 for coalition patients.

DATA SOURCE

- Patient Record and the *ASIA or Combat Neuro Exam worksheet*
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed. The system review and data analysis will be performed by the JTS Chief and the PI Branch.

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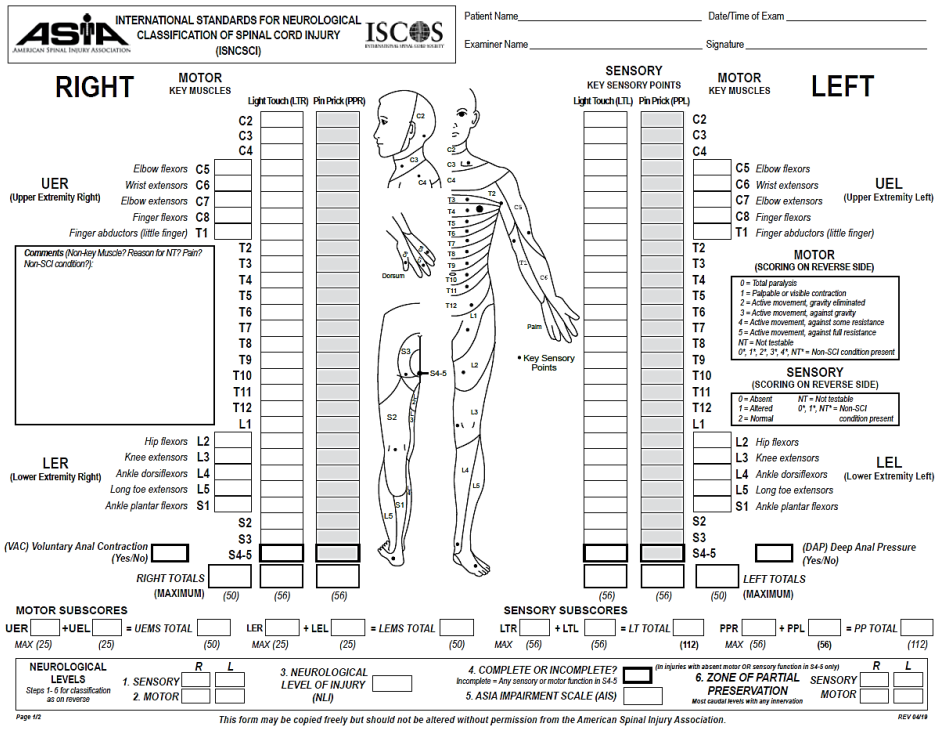
APPENDIX A: AMERICAN SPINAL INJURY ASSOCIATION (ASIA) WORKSHEET

Download form here:
https://jts.health.mil/assets/docs/forms/ASIA_International_Stds_Diagram_Worksheet.pdf


INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY
(ISNCSCI)
Patient Name
Date/Time of Exam
Examiner Name
Signature
RIGHT
LEFT
MOTOR KEY MUSCLES
SENSORY KEY SENSORY POINTS
Light Touch (LTR)
Pin Prick (PPR)
Light Touch (LTL)
Pin Prick (PPL)
UER (Upper Extremity Right)
UEL (Upper Extremity Left)
LER (Lower Extremity Right)
LEL (Lower Extremity Left)
Elbow flexors C5
Wrist extensors C6
Elbow extensors C7
Finger flexors C8
Finger abductors (little finger) T1
Hip flexors L2
Knee extensors L3
Ankle dorsiflexors L4
Long toe extensors L5
Ankle plantar flexors S1
Comments (Non-Key Muscle? Reason for NT? Pain? Non-SCI condition?):
MOTOR (SCORING ON REVERSE SIDE)
0 = Total paralysis
1 = Palpable or visible contraction
2 = Active movement, gravity eliminated
3 = Active movement, against gravity
4 = Active movement, against some resistance
5 = Active movement, against full resistance
NT = Not testable
0*, 1*, 2*, 3*, 4*, NT* = Non-SCI condition present
SENSORY (SCORING ON REVERSE SIDE)
0 = Absent
1 = Altered
2 = Normal
NT = Not testable
0*, 1*, NT* = Non-SCI condition present
(VAC) Voluntary Anal Contraction (Yes/No)
(DAP) Deep Anal Pressure (Yes/No)
RIGHT TOTALS
LEFT TOTALS
(MAXIMUM)
MOTOR SUBSCORES
SENSORY SUBSCORES
UER + UEL = UEMS TOTAL
LER + LEL = LEMS TOTAL
LTR + LTL = LT TOTAL
PPR + PPL = PP TOTAL
NEUROLOGICAL LEVELS
Steps 1- 6 for classification as on reverse
1. SENSORY
2. MOTOR
3. NEUROLOGICAL LEVEL OF INJURY (NLI)
4. COMPLETE OR INCOMPLETE?
Incomplete = Any sensory or motor function in S4-5
5. ASIA IMPAIRMENT SCALE (AIS)
6. ZONE OF PARTIAL PRESERVATION
Most caudal levels with any innervation
(In injuries with absent motor OR sensory function in S4-5 only)
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REV 04/19

Muscle Function Grading

0 = Total paralysis

1 = Palpable or visible contraction

2 = Active movement, full range of motion (ROM) with gravity eliminated

3 = Active movement, full ROM against gravity

4 = Active movement, full ROM against gravity and moderate resistance in a muscle specific position

5 = (Normal) active movement, full ROM against gravity and full resistance in a functional muscle position expected from an otherwise unimpaired person

NT = Not testable (i.e. due to immobilization, severe pain such that the patient cannot be graded, amputation of limb, or contracture of > 50% of the normal ROM)

0*, 1*, 2*, 3*, 4*, NT* = Non-SCI condition present *a*

Sensory Grading

0 = Absent **1** = Altered, either decreased/impaired sensation or hypersensitivity

2 = Normal **NT** = Not testable

0*, 1*, NT* = Non-SCI condition present *a*

Note: Abnormal motor and sensory scores should be tagged with a '' to indicate an impairment due to a non-SCI condition. The non-SCI condition should be explained in the comments box together with information about how the score is rated for classification purposes (at least normal / not normal for classification).

When to Test Non-Key Muscles:

In a patient with an apparent AIS B classification, non-key muscle functions more than 3 levels below the motor level on each side should be tested to most accurately classify the injury (differentiate between AIS B and C).

Movement	Root level
Shoulder: Flexion, extension, adbuction, adduction, internal and external rotation **Elbow:** Supination	C5
Elbow: Pronation **Wrist:** Flexion	C6
Finger: Flexion at proximal joint, extension **Thumb:** Flexion, extension and abduction in plane of thumb	C7
Finger: Flexion at MCP joint **Thumb:** Opposition, adduction and abduction perpendicular to palm	C8
Finger: Abduction of the index finger	T1
Hip: Adduction	L2
Hip: External rotation	L3
Hip: Extension, abduction, internal rotation **Knee:** Flexion **Ankle:** Inversion and eversion **Toe:** MP and IP extension	L4
Hallux and Toe: DIP and PIP flexion and abduction	L5
Hallux: Adduction	S1

ASIA Impairment Scale (AIS)

A = Complete. No sensory or motor function is preserved in the sacral segments S4-5.

B = Sensory Incomplete. Sensory but not motor function is preserved below the neurological level and includes the sacral segments S4-5 (light touch or pin prick at S4-5 or deep anal pressure) AND no motor function is preserved more than three levels below the motor level on either side of the body.

C = Motor Incomplete. Motor function is preserved at the most caudal sacral segments for voluntary anal contraction (VAC) OR the patient meets the criteria for sensory incomplete status (sensory function preserved at the most caudal sacral segments S4-5 by LT, PP or DAP), and has some sparing of motor function more than three levels below the ipsilateral motor level on either side of the body. (This includes key or non-key muscle functions to determine motor incomplete status.) For AIS C – less than half of key muscle functions below the single NLI have a muscle grade ≥ 3.

D = Motor Incomplete. Motor incomplete status as defined above, with at least half (half or more) of key muscle functions below the single NLI having a muscle grade ≥ 3.

E = Normal. If sensation and motor function as tested with the ISNCSCI are graded as normal in all segments, and the patient had prior deficits, then the AIS grade is E. Someone without an initial SCI does not receive an AIS grade.

Using ND: To document the sensory, motor and NLI levels, the ASIA Impairment Scale grade, and/or the zone of partial preservation (ZPP) when they are unable to be determined based on the examination results.

AMERICAN SPINAL INJURY ASSOCIATION
INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY
INTERNATIONAL SPINAL CORD SOCIETY

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Steps in Classification

The following order is recommended for determining the classification of individuals with SCI.

1. Determine sensory levels for right and left sides.
The sensory level is the most caudal, intact dermatome for both pin prick and light touch sensation.

2. Determine motor levels for right and left sides.
Defined by the lowest key muscle function that has a grade of at least 3 (on supine testing), providing the key muscle functions represented by segments above that level are judged to be intact (graded as a 5).
Note: in regions where there is no myotome to test, the motor level is presumed to be the same as the sensory level, if testable motor function above that level is also normal.

3. Determine the neurological level of injury (NLI).
This refers to the most caudal segment of the cord with intact sensation and antigravity (3 or more) muscle function strength, provided that there is normal (intact) sensory and motor function rostrally respectively.
The NLI is the most cephalad of the sensory and motor levels determined in steps 1 and 2.

4. Determine whether the injury is Complete or Incomplete.
(i.e. absence or presence of sacral sparing)
*If voluntary anal contraction = **No** AND all S4-5 sensory scores = **0***
*AND deep anal pressure = **No**, then injury is **Complete**.*
*Otherwise, injury is **Incomplete**.*

5. Determine ASIA Impairment Scale (AIS) Grade.
Is injury Complete? If YES, AIS=A
NO ↓
Is injury Motor Complete? If YES, AIS=B
NO ↓ (No=voluntary anal contraction OR motor function more than three levels below the motor level on a given side, if the patient has sensory incomplete classification)
Are at least half (half or more) of the key muscles below the neurological level of injury graded 3 or better?
NO ↓ AIS=C
YES ↓ AIS=D
If sensation and motor function is normal in all segments, AIS=E
Note: AIS E is used in follow-up testing when an individual with a documented SCI has recovered normal function. If at initial testing no deficits are found, the individual is neurologically intact and the ASIA Impairment Scale does not apply.

6. Determine the zone of partial preservation (ZPP).
The ZPP is used only in injuries with absent motor (no VAC) OR sensory function (no DAP, no LT and no PP sensation) in the lowest sacral segments S4-5, and refers to those dermatomes and myotomes caudal to the sensory and motor levels that remain partially innervated. With sacral sparing of sensory function, the sensory ZPP is not applicable and therefore "NA" is recorded in the block of the worksheet. Accordingly, if VAC is present, the motor ZPP is not applicable and is noted as "NA".

APPENDIX B: COMBAT NEURO EXAM WORKSHEET

- Need Safety Pin or Needle DATE:_____ TIME:_____
- Perform all elements for all patients with a fracture of the vertebral body (excludes stable isolated transverse or spinous process fractures) noted on CT scan.

Fractured Vertebrae: (circle all that apply)

C1 C2 C3 C4 C5 C6 C7

T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12

L1 L2 L3 L4 L5 Sacrum

MOI: [Vehicle vs. IED] [Dismounted IED] [Fall from Ht] [Aircraft Crash] [GSW] [OTHER]

Alertness at time of exam: [Intubated/Sedated] [Intubated/Alert/Compliant] [Extubated]

External Fixation: [RUE] [LUE] [RLE] [LLE] Splint: [RUE] [LUE] [RLE] [LLE]

Motor Strength:

Elbow Flexion (C5)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Wrist Extension (C6)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Elbow Extension (C7)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

MF DIP Flex (C8)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

SF Abduction (T1)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Hip Flexion (L2)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Knee Extension (L3)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Ankle Dorsiflexion (L4)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Great Toe Extension (L5)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

Ankle Plantarflexion (S1)
LEFT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT
RIGHT: [ ]No Motion [ ]Motion against gravity [ ]Normal [ ][*] [ ]NT

MF = middle finger; SF = small finger; * Suspect NORMAL strength, but limited due to pain; NT = Not Tested

Rectal Exam:

Voluntary Anal Contraction	[ ]None	[ ]Weak	[ ]Normal
Tone	[ ]None	[ ]Weak	[ ]Normal
Pinprick Anal Sensation (S4/5)	[ ]Absent	[ ]Impaired	[ ]Normal
Anal Wink	[ ]Absent	[ ]Present	

Sensation:

Start at Clavicle and progress inferiorly until light touch sensation is abnormal. Then, test pin prick at this level and prick with sharp and then with dull surface at each dermatome. Check the LOWEST level where the patient had reliable detection of sharp and dull sensation. Indicate if levels are different on Left or Right side.

[ ]Clavicle (C3/4)
[ ]Lateral Elbow (C5)
[ ]Dorsal Thumb (C6)
[ ]Dorsal MF (C7)
[ ]Dorsal SF (C8)
[ ]Medial Elbow(T1)
[ ]Nipple Level (T4)
[ ]Xiphoid Level (T6)
[ ]Umbilicus (T10)
[ ]Mid-Inguinal Crease (T12)
[ ]Medial Thigh (Prox 1/3) (L1)
[ ]Medial Thigh (Mid Point) (L2)
[ ]Medial Knee (L3)
[ ]Medial Ankle (L4)
[ ]Dorsum Middle Toe (L5)

Reflexes:

Bulbocavernosis [ ]Absent [ ]Present [ ]Indeterminate [ ]NT

Patella LEFT: [ ]Absent [ ]Present RIGHT: [ ]Absent [ ]Present

Clonus LEFT: [ ]Absent [ ]Present RIGHT: [ ]Absent [ ]Present

Foley: [ ]Present [ ]Voiding spontaneously without catheter.

ASIA Score: (circle score)

[A] COMPLETE (no motor/sensory function below level of injury)

[B] Pinprick sensation PRESENT at anus (S4/5) – NO Motor

[C] <½ the muscles below level of injury have motion against gravity

[D] >½ the muscles below level of injury have motion against gravity

[E] Normal

NEURO LEVEL: _____ (Lowest level with normal sense and at least antigravity strength)1

Incomplete Syndrome: (SCI – Occ-T11 Fx) (Conus – T12-L2 Fx) (CES – L3-Sacrum)

MF = middle finger; SF = small finger; * Suspect NORMAL strength, but limited due to pain; NT = Not Tested

APPENDIX C: SCREENING FOR BLUNT CEREBROVASCULAR INJURY

Expanded Screening Criteria for Blunt Cerebrovascular Injury (BCVI)[12]

Signs and Symptoms of BCVI

- Arterial hemorrhage from neck, nose, or mouth.
- Cervical bruit in patient <50 years of age.
- Cervical hematoma.
- Focal neurologic deficit inconsistent with head CT.
- Ischemic change on head CT.

Risk Factors for BCVI

- High-energy mechanism.
- LeFort II or III facial fracture, or mandible fracture.
- Skull or skull-base fracture.
- Severe TBI, as defined by GCS < 6.
- Cervical fracture, subluxation, or ligamentous injury.
- "Clothesline," "seat-belt," or "hanging"-type mechanism of injury.
- TBI with associated thoracic injuries.
- Thoracic vascular injuries or upper rib fractures.
- Scalp de-gloving injury.
- Blunt cardiac injuries.

APPENDIX D: SUMMARY OF PERFORMANCE OF MYELOGRAPHY

(Adapted from Omnipaquetm package insert)

BACKGROUND:

Iohexol is a non-ionic, water-soluble contrast agent with 46.36% iodine content. It is excreted renally.

Available concentrations include: 140, 180, 240, 300 and 350 milligrams of iodine per milliliter.

Omnipaque 180, 240 and 300 are indicated for intrathecal use in adults.
DO NOT ADMINISTER OMNIPAQUE 140 OR 350 INTRATHECALLY.

Contraindications: known hypersensitivity to iohexol; active local/systemic infection; co-administration of intra-thecal corticosteroids; overdose; significant intra-cranial entry; use in patient with epilepsy; grossly bloody CSF; co-administration with: phenothiazines, MAOI, TCA, CNS stimulants, antipsychotics.

Adverse occurrences: headache, meningismus, nausea, seizure, anaphylaxis. With inadvertent administration of Omnipaque not indicated for intrathecal use: death, seizure, cerebral hemorrhage, arachnoiditis, renal failure, rhabdomyolysis, hyperthermia, cerebral edema.

TECHNIQUE:

A total of 3,060 milligrams of iodine should not be exceeded in one study in an adult patient.

For total columnar myelography, instill 6-12.5 mL of Omnipaque 240, or 6-10 mL of Omnipaque 300, via standard lumbar puncture over 1-2 minutes. To allow time for complete opacification of the subarachnoid space, obtain CT roughly 15-30 minutes, but not more than 1 hour, after contrast injection.

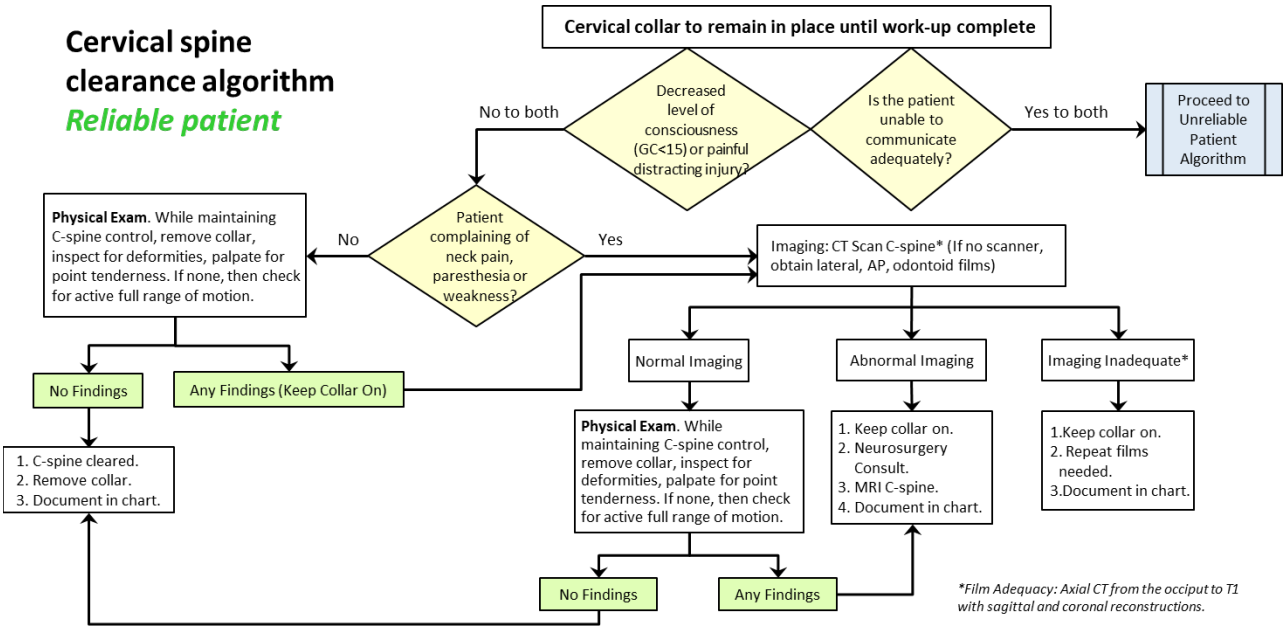
The patient should remain hydrated and observed for at least 12 hours post myelogram. Avoid excessive entry of contrast intracranially and maintain elevated head-of-bed once the study is complete.

Full details can be viewed in the OmnipaqueTM (iohexol) package insert, freely available at:

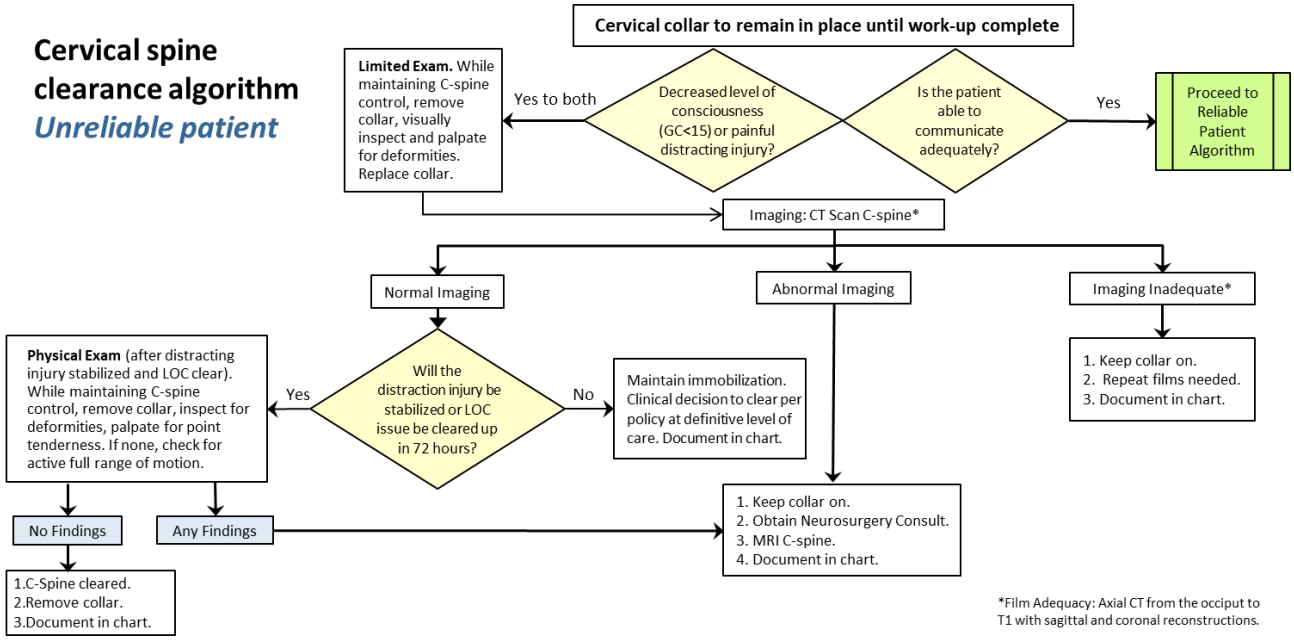
https://www.accessdata.fda.gov/drugsatfda_docs/label/2017/018956s099lbl.pdf

APPENDIX E: CERVICAL SPINE CLEARANCE ALGORITHM RELIABLE PATIENT

Patient is without neurologic deficit.


Cervical spine clearance algorithm
Reliable patient
Cervical collar to remain in place until work-up complete
Decreased level of consciousness (GC<15) or painful distracting injury?
Is the patient unable to communicate adequately?
No to both
Yes to both
Proceed to Unreliable Patient Algorithm
Physical Exam. While maintaining C-spine control, remove collar, inspect for deformities, palpate for point tenderness. If none, then check for active full range of motion.
No
Patient complaining of neck pain, paresthesia or weakness?
Yes
Imaging: CT Scan C-spine* (If no scanner, obtain lateral, AP, odontoid films)
No Findings
Any Findings (Keep Collar On)
1. C-spine cleared.
2. Remove collar.
3. Document in chart.
Normal Imaging
Abnormal Imaging
Imaging Inadequate*
Physical Exam. While maintaining C-spine control, remove collar, inspect for deformities, palpate for point tenderness. If none, then check for active full range of motion.
1. Keep collar on.
2. Neurosurgery Consult.
3. MRI C-spine.
4. Document in chart.
1.Keep collar on.
2. Repeat films needed.
3.Document in chart.
No Findings
Any Findings
*Film Adequacy: Axial CT from the occiput to T1 with sagittal and coronal reconstructions.

APPENDIX F: CERVICAL SPINE CLEARANCE ALGORITHM UNRELIABLE PATIENT


Cervical spine clearance algorithm
Unreliable patient
Cervical collar to remain in place until work-up complete
Limited Exam. While maintaining C-spine control, remove collar, visually inspect and palpate for deformities. Replace collar.
Yes to both
Decreased level of consciousness (GC<15) or painful distracting injury?
Is the patient able to communicate adequately?
Yes
Proceed to Reliable Patient Algorithm
Imaging: CT Scan C-spine*
Normal Imaging
Abnormal Imaging
Imaging Inadequate*
Physical Exam (after distracting injury stabilized and LOC clear). While maintaining C-spine control, remove collar, inspect for deformities, palpate for point tenderness. If none, check for active full range of motion.
Yes
Will the distraction injury be stabilized or LOC issue be cleared up in 72 hours?
No
Maintain immobilization. Clinical decision to clear per policy at definitive level of care. Document in chart.
1. Keep collar on.
2. Repeat films needed.
3. Document in chart.
No Findings
Any Findings
1. Keep collar on.
2. Obtain Neurosurgery Consult.
3. MRI C-spine.
4. Document in chart.
1.C-Spine cleared.
2.Remove collar.
3.Document in chart.
*Film Adequacy: Axial CT from the occiput to T1 with sagittal and coronal reconstructions.

APPENDIX G: CERVICAL SPINE CLEARANCE STATUS

Download form here:
https://jts.health.mil/assets/docs/forms/Cervical_Spine_Clearance_Status_Notes.pdf

Cervical Spine Clearance Status Notes
Joint Trauma System

Mechanism: ☐ Explosive ☐ M/C ☐ Fall ☐ Other

Notes:

Collar placed: ☐ Prehospital ☐ Hospital ☐ No collar

Patient reliable? ☐ Yes ☐ No Reason unreliable? ☐ Altered Mental Status (GCS<15) ☐ Significant Distracting Injury

Notes:

Patient complaints ☐ None ☐ Neck pain (specify location:) ☐ Paresthesia

Notes:

Physical Findings

Inspection: ☐ Normal ☐ Abnormal specify:

Palpation: ☐ Normal ☐ Point tenderness ☐ Deformity

Notes:

Active range of motion: ☐ Full ☐ Limited specify:

Notes:

Imaging Studies (CT is standard. Films acceptable only when CT is unavailable.)

CT scan: ☐ Normal ☐ Abnormal specify:

Notes:

Lateral: ☐ Normal ☐ Abnormal specify:

AP: ☐ Normal ☐ Abnormal specify:

Odontoid: ☐ Normal ☐ Abnormal specify:

C L E A R A N C E

Cervical spine is:

☐ CLEAR of significant injury and instability on the basis of the following:
- ☐ Normal exam in completely reliable patient with no need for imaging
- ☐ Normal imaging of full C-Spine and normal exam.

☐ NOT CLEAR on the basis of the following:
- ☐ Neurological complaint or abnormal physical exam finding
- ☐ Abnormal imaging
- ☐ Unreliable patient at time of evacuation/final disposition

Physician name Physician signature Date

MTF

Medical Record (Rev. May 2018)

APPENDIX H: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Chemical, Biological, Radiological and Nuclear (CBRN) Injury Response Part 2: Medical Management of Chemical Agent Exposure (CPG ID:69)

This guideline is intended for use in conjunction with Tactical Combat Casualty Care Guidelines as an organized approach to the care of CBRN casualties.

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Summary of Changes

1) Updated Naloxone dosing
2) Updated atropine/scopolamine SOP
3) Updated sequence of action for nerve agent exposure

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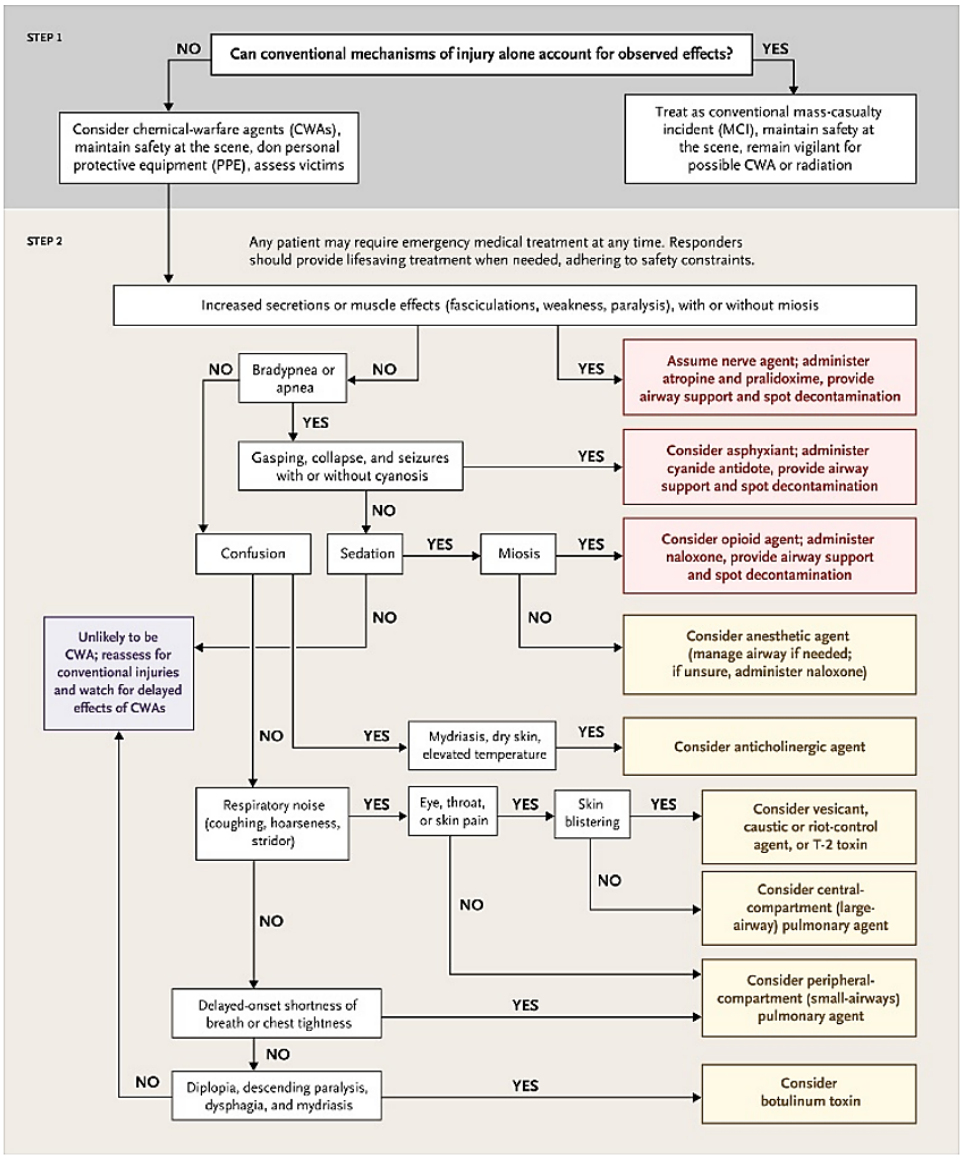
INTRODUCTION

The following is a review of the medical management of specific chemical agents in the continuum of care from point of injury (POI) through Role 3. More detailed information is available in the Field Management of Chemical and Biological Casualties Handbook.[1] Rapid reference cards are included for each category of agent. Discussion of the recommendations included in the rapid reference cards are in the text below. Additionally, the below flow chart can be referenced to rapidly triage for chemical warfare agents based on clinical presentation. Diagnostic testing and/or treatment decisions will be made based on resource availability and the tactical situation at each phase of care. Tactical combat casualty care guidelines should be incorporated into the care of the chemically exposed casualty using (MARCHE)[2] as described in the JTS Chemical, Biological, Radiological and Nuclear Injury Response Part I: Initial Response Clinical Practice Guideline. [2]

Figure 1. Toxidrome-based Rapid Identification of Chemical-Warfare Agent Classes


STEP 1
Can conventional mechanisms of injury alone account for observed effects?
NO
YES
Consider chemical-warfare agents (CWAs), maintain safety at the scene, don personal protective equipment (PPE), assess victims
Treat as conventional mass-casualty incident (MCI), maintain safety at the scene, remain vigilant for possible CWA or radiation
STEP 2
Any patient may require emergency medical treatment at any time. Responders should provide lifesaving treatment when needed, adhering to safety constraints.
Increased secretions or muscle effects (fasciculations, weakness, paralysis), with or without miosis
Bradypnea or apnea
Assume nerve agent; administer atropine and pralidoxime, provide airway support and spot decontamination
Gasping, collapse, and seizures with or without cyanosis
Consider asphyxiant; administer cyanide antidote, provide airway support and spot decontamination
Confusion
Sedation
Miosis
Consider opioid agent; administer naloxone, provide airway support and spot decontamination
Unlikely to be CWA; reassess for conventional injuries and watch for delayed effects of CWAs
Consider anesthetic agent (manage airway if needed; if unsure, administer naloxone)
Mydriasis, dry skin, elevated temperature
Consider anticholinergic agent
Respiratory noise (coughing, hoarseness, stridor)
Eye, throat, or skin pain
Skin blistering
Consider vesicant, caustic or riot-control agent, or T-2 toxin
Consider central-compartment (large-airway) pulmonary agent
Consider peripheral-compartment (small-airways) pulmonary agent
Delayed-onset shortness of breath or chest tightness
Diplopia, descending paralysis, dysphagia, and mydriasis
Consider botulinum toxin

Source: Toxidrome Recognition in Chemical-Weapons Attacks, Ciottone GR. 26 Apr 2018. N Engl J Med 2018; 378:1611-1620.

CYANIDE EXPOSURE

BACKGROUND

Cyanide has historically been an uncommon warfare agent; however, its lethality and availability worldwide make it a realistic and potential agent of terrorism. Cyanide was found in the Tokyo subway after the Sarin attacks[3,4] and reported to have possibly been a contaminant in the explosives of the World Trade Center bombing in 1993.[5,6] Cyanide is most likely to be employed in the volatile, water soluble, and liquid forms of hydrogen cyanide (AC) and cyanogen chloride (CK). The reactive salt forms of cyanide (potassium, sodium, and calcium cyanide) are also used in industry and produce hydrogen cyanide (HCN) gas when mixed with an acid. Cyanide is highly volatile and readily transforms from liquid to the potent gas form (HCN). HCN is released by pyrolysis of synthetic polymers such as burning plastics and may be released in structural fires. Because it is lighter than air, it disperses quickly in open spaces. Cyanogen chloride, however, is heavier than air and thus is a more persistent agent.

SIGNS AND SYMPTOMS

Cyanide can cause symptoms within seconds to minutes of inhalational exposure. While it is classified as a blood agent, the early symptoms are cardiotoxicity and central nervous system (CNS) effects. The initial symptoms can be non-specific and transient. Dizziness, headache, weakness, diaphoresis, and dyspnea are all possible and leave a broad differential diagnosis. The well-described odor of bitter almonds is not a reliable sign as many cannot detect the odor. The hallmark clinical presentation that leads to diagnosis is tissue hypoxia without cyanosis (pulse oximetry may be normal) with the finding of metabolic acidosis. Without rapid treatment, the patient is likely to rapidly progress to coma, hemodynamic compromise, arrhythmias, seizures, secondary cardiac arrest, and eventually death.

DECONTAMINATION

Victims exposed to cyanide should be rapidly removed from the location of exposure while ensuring that the rescuer is protected. For gas exposure, evacuating from the location and then removing all clothing addresses the majority of decontamination. Further decontamination with irrigation solutions can be done, but treatment with antidote is the first priority and should not be delayed.

DIAGNOSTICS

Prompt diagnosis to facilitate treatment is essential. However, in a tactical environment, the availability of diagnostic adjuncts is limited. Cyanide levels are not rapidly available and not useful in the acute phase of care. The clinical picture coupled with arterial blood gas demonstrating metabolic acidosis and very high lactate levels should alert the clinician to possible cyanide exposure.[7] This can be an extremely challenging diagnosis in the setting of trauma with massive hemorrhage and hypovolemic shock. Thus a high index of suspicion and awareness of intelligence indicating risk of exposure are key to early diagnosis. Drawing an arterial and venous blood gas at the same time and comparing the oxygen content can be helpful. “Arterialization of venous blood” (similar color/PaO2 of samples) can help round out the clinical picture. From a practical standpoint, it is unlikely that the provider will have diagnostic support in the hot or warm zone, so the decision to treat will be entirely clinical. Fortunately, with the availability of hydroxocobalamin (discussed in detail below), the side effects of empiric administration of the antidote are minimized when compared to the previously used cyanide antidote kit.

Table 1. Blood Agents

Blood Agents - Cyanide Treatment	**Agent Properties** Hydrogen cyanide, Cyanogen chloride Volatile water-soluble liquid M8 Paper: does not detect Odor: Bitter almonds	**PPE Requirements** Mask and AP-PPE, JLIST, or UIPE **Lethality** LCt50 HCN 500mg min/m3 LCt50 CK 1.1g min/m3	**CRESS Symptomatic Presentation** **C**: altered or unconscious **R**: normal to apneic **E**: normal unless vapor irritant **S**: none **S**: may be flushed (50% of the time)
POI Hot Zone	Immediate Action: Self Aid, Buddy Aid, Move (Upwind, Upstream, Uphill) Away from Threat **M^2:** **M**assive hemorrhage / **M**ask check **A^2:** **A**irway (assess) / **A**ntidote (Cyanokit) **R^2:** **R**espiration (assess) / **R**apid Spot Decon **E:** **E**xtraction (egress away from threat)		High concentrations of cyanide can result in death within seconds to minutes. Early symptoms may include dizziness, headache, weakness, diaphoresis, and dyspnea/hyperpnea. CNS and cardiotoxicity occur due to intracellular hypoxia. Consider amyl nitrite (0.3mL ampule)
Dirty CCP Warm Zone	**M^2 A^2 R^2** Reassessment, clear airway, O2 as needed, maintain filtered air **Decon & Cutout:** Remove and bag equipment, PPE, and clothing Evacuation from exposure + clothing removal is adequate decon Can further decontaminate skin with irritation solution, but priority is antidote **C^2:** **C**irculation (assess vitals, resuscitate) / Countermeasures (Cyanokit) **H^2:** **H**ypothermia (prevent) / Head wounds (assess mental status--altered due to agent or TBI?) **E:** **E**vacuation		**Cyanokit 5gm IV over 5 min in 200mL NS** Decision to give in hot or warm zone is based on clinical presentation. Unlikely to have diagnostic adjuncts (lactate, arterial/venous samples) prior to cold zone. If Cyanokit (hydroxocobalamin) antidote is not available, aggressive supportive care may be sufficient treatment.
Cold Zone	**(MARCHE)^2 Reassessment** **C^2**: Circulation (Assess vitals, resuscitate)/Countermeasures **Supplemental O_2** (even with normal SpO_2) **Cyanokit** 5gm IV over 5 min in 200mL NS (May give second dose if first not effective) **H^2**: Hypothermia (HPMK, fluid warmer)/Head wounds (treat elevated ICP, Neuro exam, MACE)	**PFC**: Supportive care Anticipate hemodynamic compromise, seizures, cardiac arrhythmias **Bedside diagnosis**: draw venous and arterial samples, similar color of samples indicates arteriolization of venous blood **Lactate** elevated, cyanide levels not useful *When Cyanokit (hydroxocobalamin) antidote is not available, cyanide antidote kit may be used; side effect methemoglobinemia and vasodilation are problematic if concomitant trauma*	
Reachback: USAMRICD (410) 436-2230 DSN: (312) 584-2230			

Terms: PPE: personal protective equipment; AP-PPE: all-purpose personal protective ensemble; JLIST: joint lightweight integrated suit technology; UIPE: undergarment integrated protective ensemble; LCt50: lethal concentration, 50%; LD50: lethal dose, 50%; CRESS: Consciousness, Respirations, Eyes, Secretions, Skin; ATNAA: antidote treatment nerve agent auto-injector; CANA: convulsive antidote nerve agent; RSDL: reactive skin decontaminant lotion; HPMK: hypothermia management kit; TBI: traumatic brain injury; ICP: intracerebral pressure; MACE: military acute concussion evaluation; PFC: prolonged field care; USAMRICD: US Army Medical Research Institute of Chemical Defense

TREATMENT

The mainstay of treatment is antidote therapy with hydroxocobalamin. Attention to supportive care is a critical part of the resuscitation. Airway management, intravenous access, and cardiac monitoring can support a cyanide-poisoned patient. Supplemental oxygen is beneficial and may enhance antidote efficacy and promote cyanide respiratory excretion along with other metabolic processes. Historically, cyanide was treated with the cyanide antidote kit consisting of amyl nitrite, sodium nitrite, and sodium thiosulfate. The nitrites induce methemoglobinemia, as a side effect which may be detrimental in a patient with concomitant trauma. The preferred antidote is now hydroxocobalamin (Cyanokit). However, if hydroxocobalamin is not available, the cyanide antidote kit can be used. An inhaled ampule of amyl nitrite can be a temporizing measure until IV/IO access is established.

Hydroxocobalamin (vitamin B12a) acts as a chelating agent and binds with cyanide to form cyanocobalamin (vitamin B12). The dose of hydroxocobalamin for cyanide toxicity is much higher than the dose used for other therapeutic indications, therefore the commercially prepared hydroxocobalamin is needed to get the optimal dose without volume overload: 5gm IV (70mg/kg in pediatric patients) over 15 minutes. The dose can be repeated for severe toxicity or inadequate response to the initial dose. It is as effective as epinephrine in the setting of cardiac arrest from cyanide. It may cause a red discoloration of the skin and urine that persists for several weeks. Other side effects are mild. The decision to administer hydroxocobalamin within the hot or warm zone has to be weighed against the tactical risk of stopping to gain IV or IO access and establishing the infusion.

Other treatment regimens as well as prophylactic measures have been explored in the literature and are summarized in the table below.

Table 2. Other Treatment Regimens

Agent	Intervention	Highlights	References
Cyanide Treatment	hydroxocobalamin (Cyanokit®) 5gm IV over 15 min (may repeat dose for severe toxicity or poor clinical response). Can be given IO	Effective as single agent. As effective as epinephrine in the setting of cardiac arrest	Sauer 2001[8] Bebarta 2010[9] Bebarta 2012[10] Bebarta 2014[11] Brouard, 1987[12]
	Cyanide antidote kit Amyl nitrite 0.3mL Sodium nitrite 300mg Sodium thiosulfate 12.5gm	Suboptimal due to formation of methemoglobinemia which could be deleterious in the setting of concomitant trauma. Thiosulfate alone not effective	Bebarta 2012[10] Hall 1987[13]
	hydroxocobalamin + sodium thiosulfate	Theoretical benefit, but did not result in benefit in swine model of shock from cyanide poisoning	Bebarta 2012[10]
	Cobinamide	As effective as hydroxocobalamin in animal model. May have future promise for IM/IO use	Bebarta 2014[14]
Cyanide Prophylaxis	Alpha-ketoglutarate	Potential benefit as prophylactic and/or adjunct agent with antidote	Dulaney 1991[15]
	N-acetylcysteine (NAC)	Benefit up to 60 minutes before exposure when given with alpha-ketoglutarate	Dulaney 1991[15]
	Dihydroxyacetone (DHA)	Benefit in animals (oral and IV)	Niknahad 2002[16]
Hydrogen Sulfide (acts as simple asphyxiant/ irritant but included as blood agent due to HS cytochrome oxidase inhibition)	Sodium nitrite 300mg IV over 5-7 minutes	Anecdotal evidence if given shortly after exposure. Supportive care is often sufficient treatment if patient survives exposure	Hoffman 2015[17]

NERVE AGENT EXPOSURE

BACKGROUND

Nerve agents, or acetylcholinesterase inhibitors, are some of the most lethal substances ever to be weaponized. These agents exist in multiple forms from thick viscous liquids to highly dissolvable gases. They are chemically similar to organophosphates used for pesticides, and the syndromes they cause are much more common in farming communities than they are on the battlefield. The most lethal forms only require 1/1000th of an ounce to obtain a lethal dose in 50% of exposed population (LD50).

Nerve agents consist of mainly two classes, V agents and G agents. V agents are viscous in nature and can be spread in numerous ways. They are extremely dangerous if touched or ingested but can also pose a vapor hazard in close proximity. G agents are liquids at room temperature and are extremely effective as chemical weapons due to the ability to quickly expose a large number of people to lethal inhaled doses by vapor exposure.

Physiologically, these agents bind to acetylcholinesterase, thus inhibiting breakdown of acetylcholine. The two main types of cholinergic receptors where nerve agents interact are muscarinic and nicotinic. Muscarinic receptors are located in the smooth muscles and the glands. Symptoms caused by over-stimulation of muscarinic receptors can be recalled using the DUMBBELS mnemonic (Diarrhea, Urination, Miosis, Bronchorrhea/Bronchoconstriction, Bradycardia, Emesis, Lacrimation, Salivation). These symptoms can be countered by atropine (discussed later in the treatment section). Nicotinic receptors located in skeletal muscle and nerve ganglia are also affected by nerve agents. Symptoms caused by over-stimulation of nicotinic receptors can be remembered by using the first letter of the days of the week as a memory assist (Mydriasis, Tachycardia, Weakness, Hypertension, Fasciculations). Administration of pralidoxime (2PAM) restores cholinesterase activity which typically results in improvement of the nicotinic symptoms.

SIGNS AND SYMPTOMS

Nerve agent poisoning can range from mild to severe; a severe exposure may quickly lead to death if not reversed. Rapid antidote treatment is extremely important since some nerve agents can irreversibly bind to acetylcholinesterase (for example, the half-life for irreversible binding, termed aging half-life, for soman/GD is two minutes).

For mildly affected individuals not wearing eye protection, miosis is commonly seen. Other obvious muscarinic effects include severe lacrimation and profuse sweating, followed by nausea and vomiting, along with dyspnea and shortness of breath due to bronchorrhea and bronchoconstriction. More severely affected patients will have all of these signs and symptoms as well as profound weakness, fasciculations, seizures, loss of consciousness, apnea and death.

The speed of symptom onset depends on the route of exposure and dose of the agent. Inhalational exposure tends to result in faster onset of symptoms and can quickly cause death due to rapid systemic distribution. Dermal exposures, such as exposures with V agents, can cause delayed onset of symptoms.

Table 3. Nerve Agents

Nerve Agent (GA, GB, GD, GF, VX) and Organophosphate Treatment	**Agent Properties** Vapor or liquid. Variable aging (**GD** 2min) G non-persistent, V persistent M8 Paper: G - yellow, V- green	**PPE Requirements** Mask and AP-PPE, JLIST, or UIPE **LETHALITY (VX most potent)** LCt50 15-70mg min/m3 LD50 3-4000mg	**CRESS Symptomatic Presentation** **C**: altered, unconscious, seizures **R**: tachypnea, wheezing, respiratory distress **E**: miosis (may not be present with some organophosphates) **S**: copious secretions (salivation, lacrimation, bronchorrhea) **S**: diaphoresis
POI HOT ZONE	**Immediate Action:** Self Aid**,** Buddy Aid, Move (Upwind, Upstream, Uphill) Away from Threat **M²**: **M**assive hemorrhage / **M**ask check **A²**: **A**irway (assess) / **A**ntidote (ATNAAx3, CANAx1) **R²**: **R**espiration (assess) **/ R**apid Spot Decon (RSDL, M295, Fibertect) **E**: **E**xtraction (egress away from threat)		Exposure to vapor causes almost immediate symptoms while liquid exposure may have minutes to hours delay in symptoms Muscarinic symptoms (**D**iarrhea, **U**rination, **M**iosis, **B**ronchorrhea, **B**radycardia, **E**mesis, **L**acrimation, **S**alivation) Nicotinic symptoms: (**M**ydriasis, **T**achycardia, **W**eakness, **H**ypertension, **F**asciculations) and seizures
Dirty CCP WARM ZONE	**M² A² R²** Reassessment, clear airway, O_2 as needed, maintain filtered air **Decon & Cutout:** ▪ Remove and bag equipment, PPE, and clothing ▪ Wipe away gross contamination, RSDL cut line, Cut out ▪ RSDL residual contamination on skin (>2min contact time, then wipe away) ▪ Remove and replace contaminated treatments (tourniquets, chest seals, etc) **C²: C**irculation (assess vitals, resuscitate) / **C**ountermeasures (atropine, pralidoxime, benzodiazepines) **H²: H**ypothermia (prevent) / **H**ead wounds (assess mental status--altered due to agent, antidote, or TBI?) **E**: **E**vacuation		Atropine given mistakenly to an individual not exposed to nerve agent may cause tachycardia, dry mouth, and anhydrosis and predispose to heat injury. When uncertain, favor treatment.
COLD ZONE	**(MARCHE)² Reassessment** **C2: C**irculation (Assess vitals, resuscitate) **/ C**ountermeasures Use the following as symptoms dictate: ▪ Atropine 20mg in 250mL NS IV/IO, titrate to dry respiratory secretions ▪ Pralidoxime (1-2gm in 250mL NS) IV/IO over 15-30min ▪ Benzodiazepines (midazolam preferred) 2mg IV/IO/IM, titrate to effect ▪ Scopolamine 0.8mg IV/IM after ATNAA x3 (as an adjunct to atropine) **H²: H**ypothermia (HPMK, fluid warmer) / **H**ead wounds (treat elevated ICP, Neuro exam, MACE)		**PFC**: Supportive care: Reassess frequently, follow protocols for respiratory or cardiac compromise. Patients with ONLY miosis or mild rhinorrhea do not require treatment. Acetylcholinesterase levels NOT diagnostic but may be trended. Chest X-ray useful to monitor for pulmonary edema and secondary pneumonia. Benzodiazepines can help control muscle fasciculations and seizures.
Reachback: USAMRICD (410) 436-2230 DSN: 584-2230			

DECONTAMINATION

As with most chemicals, removing the exposed patient from the contaminated area to prevent further exposure and damage is the most important step. In vapor exposures, this means removing the casualty from the area and quickly removing any article of clothing or piece of equipment with possible agent contamination.

Reactive skin decontamination lotion (RSDL) is largely accepted as the most effective decontaminate for nerve agent dermal exposure. Covering all exposed skin with RSDL as quickly as possible can be a life-saving measure. If RSDL is not available, 0.5% hypochlorite solution or soap and water are alternatives. Decontamination should not be delayed if RSDL is not available. For casualties exhibiting moderate to severe symptoms (respiratory distress, seizures, altered consciousness), antidotes should be administered immediately while initiating decontamination.

NERVE AGENT DIAGNOSTICS

Diagnosis of nerve agent exposure is based on rapid identification of the clinical symptoms and identification of the agent through detection methods. Laboratory measurement of serum acetylcholinesterase levels is not useful for nerve agent exposure since the value does not correlate with signs and symptoms or prognosis. There is no utility in baseline ACHE levels due to intra-individual variability.

NERVE AGENT TREATMENT

Nerve agent antidotes include 2PAM, atropine, and benzodiazepines. Autoinjectors to treat nerve agent toxicity are available as Autoinjector Nerve Agent Antidote (ATNAA) which contains atropine and 2PAM, and Convulsant Antidote Nerve Agent (CANA) which contains the benzodiazepine diazepam.

2PAM

Pralidoxime (ATNAA autoinjector or IV/IO) reverses the bond between the acetylcholinesterase and the nerve agent and thus prevents irreversible binding to acetylcholinesterase, termed aging. 2PAM is available both in autoinjector form as well as in an IV form. 2PAM is known to work synergistically with atropine (some 30x greater). The are other oximes with varying effects depending on the agent, but pralidoxime is the available agent in DoD inventory.

Atropine

Atropine (ATNAA autoinjector or IV/IO) is used to treat the muscarinic effects. Atropine will help dry secretions (bronchorrhea) and counter the effects of the bronchoconstriction caused by the nerve agent. The amount of nerve agent and the degree of symptoms a patient is experiencing will determine the amount of atropine required to control symptoms. Large doses of atropine may be required to counter the effects of some nerve agent exposures, in particular organophosphates. Tachycardia is NOT a contraindication for atropine administration, as tachycardia may be secondary to respiratory distress. Therefore, atropine treatment should be titrated to achieve reversal of life-threatening bronchorrhea and bronchoconstriction even in the setting of tachycardia.

Benzodiazepines

Benzodiazepines, such as diazepam (CANA) or midazolam are the mainstay of seizure treatment. Benzodiazepines may also help counter nicotinic effects, particularly muscle fasciculations. Current literature recognizes midazolam as the most effective seizure reversal agent, based on animal studies. Midazolam has the fastest bioavailability when given intramuscularly (IM). Diazepam is the benzodiazepine in autoinjectors and is efficacious, but it is entirely appropriate to use another benzodiazepine when IV access has been established or when autoinjectors have been depleted.

Nerve agent antidotes may be dosed based on the severity of symptoms. However, in a field environment when the amount and type of nerve agent exposure are unknown, give 3 ATNAAs and 1 CANA for any symptomatic patient (other than isolated miosis) with suspected nerve agent exposure. If symptoms persist beyond this treatment, consider an atropine drip (see atropine/scopolamine protocol in Appendix A). For severe poisoning, additional 2PAM can be given after delivering 3 ATNAAs. There is a paucity of literature to guide dosing but current subject matter expert consensus is to dose an additional 500mg IV/IO over 5 minutes and then an infusion of 10mg/kg/hr until clinical improvement is stable which may require infusion for more than 24 hours. (See Appendix B.)

Prophylaxis

The planning considerations and the risk:benefit analysis in the decision to use pyridostigmine bromide (PB) prophylaxis is outside the scope of this CPG. However, it is important for providers to understand the clinical effects experienced by those on pyridostigmine prophylaxis and how pre-treatment can affect clinical presentation and response to treatment. Pyridostigmine (30mg tablet) is approved by the FDA for use as a pretreatment to exposure to soman, based on efficacy in reducing soman lethality when used in conjunction with 2PAM and atropine treatment in animals. (See FDA Pyridostigmine Bromide Package Insert.)[18] There are no human studies.

Pyridostigmine acts by inhibiting a portion (20-40%) of peripheral acetylcholinesterase. It does not readily cross the blood brain barrier so it does not cause central inhibition. Thus side effects of pyridostigmine prophylaxis are typically mild cholinergic or nicotinic symptoms (diarrhea, abdominal pain, and dysmenorrhea were the most common side effects in volunteers). Pyridostigmine and mefloquine (for malaria prophylaxis) taken together may have an additive effect on the gastrointestinal tract with increased diarrhea. Opioid-associated bradycardia may be worsened when pyridostigmine is combined with opioids. Pyridostigmine may enhance the activity of depolarizing neuromuscular blocking agents (succinylcholine) but may require a higher dose of non-depolarizing neuromuscular blockers. Treatment for nerve agent toxicity is the same for patients on pyridostigmine prophylaxis

Table 4. Nerve Agent Treatment/Intervention

Agent	Intervention	Summary of evidence	References
Nerve agents **GA** **GB** **GD** **GF** **VX**	**Atropine** 2.1 mg in each ATNAA autoinjector and 2 mg in each separate atropine autoinjector; initial dose 6.1 mg (3 ATNAAs); then titrate in 2-mg increments (anticipate 10-20 mg in the first several hours)	Atropine well established as anticholinergic. Helps control seizure activity.	McDonough 2001[19] Sidell 1997[20] Sidell 1974[21] Shih 1999[22] Taylor 1985[23] Ward 1962[24]
	Scopolamine* Dosing not well established	Penetrates the blood-brain barrier and controls CNS effects of nerve agents; enhanced survival in animals when used as adjunct with 2-PAM Cl and atropine; a dose of up to 1 mg may result in a marked decrease in total atropine required	Harris 1994[25] Koplovitz 2010[26] McDonough 2001[19]
	Pralidoxime chloride (2-PAM Cl)^ 600mg by autoinjector (3x) 1-2 gm IV/IO over 20-30 minutes	Most studied and only oxime in U.S. inventory. 2-PAM effectiveness is agent dependent. In guinea pigs, 2-PAM Cl is effective against sarin and VX.	Clement 1989[27] Dawson 1994[28] Gunnarson 2000[29] Kassa 2002[30] Snider 2016[31] Wilhelm 2014[32]
	Obidoxime^**	Obidoxime offered protection against tabun, sarin, VX, and pesticide oxons in guinea pigs.	Dawson 1994[28] Kassa 2002[30] Wilhelm 2014[32] Worek 2007[33]

Agent	Intervention	Summary of evidence	References
	HI-6^**	HI-6 is considered a more broad-spectrum oxime and offered protection against tabun, sarin, cyclosarin, VX, and paraoxon in guinea pigs.	Dawson 1994[28] Hamilton 1989[34] Kassa 2002[30] Wilhelm 2014[32]
	Benzodiazepines*** Diazepam - autoinjector Standard IV/IO dose for seizures 10-20 mg (up to 40 mg may be needed) Midazolam - off label dosing recommendations for status epilepticus is 10 mg IM, typical IV/IO doses for seizure control start at 1-2 mg and titrate	Two cases in Tokyo sarin attack. One patient received diazepam 35 mg (for seizures) and the other 30 mg (for fasciculations) along with atropine and 2PAM. Both recovered without sequelae. Some data to suggest that benzodiazepines can be useful for anxiety and restlessness that may precede seizures. Midazolam shown to be effective at a lower dose and to be more rapidly absorbed IM than diazepam in animal models	Marrs 2007[35] McDonough 2001[19] Shih 2002[36]

*While scopolamine is an FDA-approved drug, its use for nerve-agent poisoning is off-label
**Obidoxime and HI-6 are not FDA approved or available in the U.S.
***While benzodiazepines are routinely used for termination of seizures, this is an off-label use of this class of medications.
^ Efficacy of oximes is species dependent, so it is difficult to extrapolate effectiveness in humans from existing animal studies.

PULMONARY AGENT EXPOSURE

BACKGROUND

Pulmonary agents (also referred to as toxic industrial chemicals and choking agents) hold historical significance as the forerunners of modern chemical warfare and still hold relevance today as likely chemical culprits given their availability. Chlorine and phosgene are produced and stored in large quantities worldwide, and could have devastating effects when vaporized. There are other agents which can produce chemical lung injury such as ammonia, hydrogen sulfide, zinc oxide, phosphorus smokes, and perfluoroisobutylene (by-product of Teflon). These agents are irritating to the lungs, but are less likely to be used in a chemical attack.

Chlorine becomes a gas at -34 ° C, and is therefore stored as a compressed liquid. Phosgene becomes a toxic gas at 47 °F. The extent of injury caused by either gas is a function of the duration and concentration of exposure. Other variables that impact toxicity include respiratory rate and depth (minute ventilation) and possibly body position.

Exposures to 30ppm of chlorine will cause coughing; more serious damage to the lungs occurs at levels above 40 to 60ppm for more than 30 minutes. Phosgene is more surreptitious and toxicity may occur below its odor threshold of 0.4ppm with prolonged exposure. Additionally olfactory fatigue can occur so an individual may only transiently notice the warning odor. Phosgene IDHL (Immediately Dangerous to Life or Health) is 2ppm whereas chlorine IDHL is 100ppm.

Both gases react with moisture in the respiratory system and undergo hydrolysis. Chlorine causes lung damage through reactions to form hydrochloric and hypochlorous acids, which in turn react with sulfhydryl groups of cysteine and cause enzyme inhibition. In addition to this reaction, hydrolysis of chlorine results in free radical generation that can lead to direct cell injury and death. Phosgene also reacts with water to form carbon dioxide

and hydrogen chloride. However, the major toxicity of phosgene is believed to occur through acylation in which phosgene interacts with sulfhydryl, amine, and hydroxyl groups causing protein and lipid denaturation, disruption of membrane structure and interference with enzyme function. Phosgene also disrupts the pulmonary surfactant layer.

PULMONARY AGENT SIGNS AND SYMPTOMS

Both gases have the ability to cause asphyxia due to displacement of oxygen if released in a confined space. More commonly, the gases act as irritants and cause damage to the respiratory tract through the mechanisms described above. Lastly, the gases can cause a systemic inflammatory response.

Chlorine has an unpleasant odor and is highly irritating. Because chlorine undergoes more rapid hydrolysis when contacting mucous membranes, it causes more immediate symptoms in the moist areas of the eyes, mouth, and upper airways. Eye pain, blepharospasm, and lacrimation are common. Other symptoms may include headache, salivation, dyspnea, cough, hemoptysis, chest burning, and vomiting.

Physical examination may reveal tachycardia, tachypnea, and possibly cyanosis. If eye irritation is present, evaluation for corneal burns/abrasions should be done with fluorescein staining of the eye. In the presence of oropharyngeal erythema, there may be more significant distal injury requiring careful assessment of the airway. Stridor, hoarseness, or aphonia may indicate laryngeal edema or laryngospasm. Oropharyngeal secretions may be copious.

Phosgene smells of fresh mown hay. It has more insidious effects, and early symptoms may be mild or absent. Typical onset of phosgene-induced symptoms occurs 2 to 6 hours after exposure and delayed symptoms have been described up to 15 hours post exposure. The major effects of phosgene are on peripheral airways, therefore dyspnea, chest tightness or pain, and cough are common symptoms. Development of hypoxia and pulmonary edema may occur hours after the onset of symptoms. Fluid shifts secondary to pulmonary edema may result in hypovolemia. Early onset of pulmonary edema portends a grave prognosis.

PULMONARY AGENT DECONTAMINATION

Safe removal from the toxic gas is the priority in chlorine or phosgene exposure. Respiratory protection for rescuers and providers in a potential exposure area is critical. Once the casualty is removed from the exposure area, decontamination should be continued with removal of all clothing. For toxic gas exposure, this removes the majority of risk from the gases. Soap and water is adequate to complete decontamination.

PULMONARY AGENT DIAGNOSTICS

There are no readily available diagnostic tests to confirm or quantify pulmonary agent toxicity. Standard tests such as arterial blood gases and chest x-rays (CXR) should be used to guide supportive care as needed. Arterial blood gases can be useful when needed to follow oxygenation, but may be normal in the early phases of phosgene exposure. PCO2 may be elevated in patients with obstructive pathophysiology and indicate a need for bronchodilators or corticosteroids.

Much like ABGs, CXR performed shortly after exposure may be normal but the patient may progress to frank pulmonary edema within a few hours. Fortunately the CXR can reveal pulmonary edema before clinical exam findings. A baseline CXR may be useful for comparison when trying to detect subtle early findings of pulmonary edema. If the CXR is normal at 8 hours, it is unlikely the patient will develop pulmonary edema.[37]

Table 5. Pulmonary Agents

Pulmonary Agents (Chlorine, Phosgene) Treatment	**AGENT PROPERTIES** Gas above 47F ($COCL_2$) 29F (Cl) Phosgene toxic below odor threshold M8 Paper: not effective Odor: Phosgene - freshly mown hay	**PPE REQUIREMENTS** Mask(C2-A1 filter), AP-PPE, JLIST, or UIPE **LETHALITY** CL IDLH 10ppm $COCl_2$ IDLH 2ppm	**CRESS SYMPTOMATIC PRESENTATION** **C**: Conscious (unconscious if asphyxia) **R**: Normal to respiratory distress, delayed onset (phosgene) **E**: Irritated, injected (chlorine) **S**: Mucous membrane irritation (rhinorrhea, salivation) **S**: Chlorine: immediate irritation (tearing and rhinorrhea); Phosgene: delayed fluid buildup
POI HOT ZONE	**Immediate Action:** Self Aid**,** Buddy Aid, Move (Upwind, Upstream, Uphill) Away from Threat **M²**: **M**assive hemorrhage / **M**ask check **A²**: **A**irway (assess) / **A**ntidote **R²: R**espiration (assess) **/ R**apid Spot Decon **E**: **E**xtraction (egress away from threat)		Onset of symptoms with phosgene can be delayed up to 24 hours. Exertion is associated with worse outcomes, so keep patients exposed to phosgene at rest
Dirty CCP WARM ZONE	**M² A² R²** Reassessment, clear airway (copious secretions), possible laryngospasm, advanced airway--be prepared for cric, ventilatory support if needed, O_2 as needed, maintain filtered air **Decon & Cutout:** ▪ Remove and bag equipment, PPE, and clothing ▪ Soap and water sufficient for skin decon ▪ Remove and replace contaminated treatments (tourniquets, chest seals, etc) **C²: C**irculation (assess vitals, resuscitate) / **C**ountermeasures **H²: H**ypothermia (prevent) / **H**ead wounds (assess mental status--altered due to agent or TBI?) **E**: **E**vacuation		Laryngospasm may occur. Anticipate airway edema and manage airway early. If advanced airway required, place largest endotracheal tube possible to facilitate suctioning. If life threatening reactive airway symptoms or dysrhythmias, consider B-agonists and/or ACLS intervention in warm zone. Weigh against delays in decon and transition to cold zone care.
COLD ZONE	**(MARCHE)² Reassessment** **C²: C**irculation (Assess vitals, resuscitate) / **C**ountermeasures ▪ Supplemental O2 ▪ Inhaled Beta agonist if wheezing (e.g. albuterol MDI) ▪ Monitor for dysrhythmia (usually transient), ACLS if indicated **H²: H**ypothermia (HPMK, fluid warmer) / **H**ead wounds (treat elevated ICP, Neuro exam, MACE)		**PFC**: Albuterol 2.5mg in 3ml NS for wheezing/bronchospasm Inhaled or systemic corticosteroids (**Inhalation Injury Protocol**) Eyes: Irrigate, evaluate for corneal burn/abrasion **Imaging:** If chest X-ray negative at 8 hrs, unlikely to develop severe pulmonary edema (delayed onset pulmonary edema may occur as late as 24 hrs with phosgene) **Severe symptoms:** PEEP, ARDS ventilation strategies, aggressive pulmonary toilet. Diuresis NOT indicated, prophylactic antibiotics NOT indicated.
Reachback: USAMRICD (410) 436-2230 DSN: 584-2230			

PULMONARY AGENT TREATMENT

Chlorine exposures may lead to copious secretions and laryngospasm shortly following exposure, therefore providers should be prepared for airway management and possibly emergent surgical airway control. It is important to remember that phosgene-exposed patients, despite being asymptomatic, need to be treated as casualties. Such casualties should be kept at rest, as exertion is associated with pulmonary edema and worse outcomes in phosgene-exposed patients. If an advanced airway is placed, a large-bore endotracheal tube will facilitate pulmonary toilet as toxic gas exposures can cause sloughing of mucosa and clogging of the airway with debris.

Intravenous fluids may be necessary in the setting of volume depletion, but should not be given empirically. Fluid overload can contribute to pulmonary edema and should be avoided. Laryngoscopy and/or bronchoscopy may be necessary, and preparations for advanced airway management must be in place should airway compromise occur. Portable ventilators with simplified automated setting (e.g. SAVe ventilators) may not be adequate for ventilation management in these patients. Because of the associated pulmonary edema, bronchospasm, and risk of ARDS, the ability to manipulate ventilator settings is crucial. Additionally, suction is a key component of maintaining patent airways, bulb suction is unlikely to be adequate and mechanical suction with the ability to do inline suction is preferred.

Advanced interventions and the supporting evidence is described in the table below. Much of the available evidence is based upon animal studies and human data is limited.

Table 6. Pulmonary Agent Intervention

Agent	Intervention	Highlights	References
Chlorine	Beta agonists (albuterol MDI) (typical bronchodilator doses)	May be useful in the setting of bronchospasm and obstructive airway disease	Nelson 2015 [38]
	Corticosteroids (typical doses given for reactive airway disease) Inhaled: fluticasone 200mcg BID budesonide 0.5-2.0mg BID	Possible benefit shown in animal studies using inhaled steroids, even without reactive airways (no human data)	Gunnarson 2000[29] Wang 2004 [39]
	Nebulized sodium bicarbonate (dilute 8.4% 1:1 with sterile water to make 4.2%)	Theoretical benefit, studies limited.	Bosse 1994 [40] Vinsel 1990 [41]
Phosgene	Corticosteroids (typical doses for reactive airway disease, IV or inhaled)	Possible benefit shown in animal studies, even without reactive airways (no human data)	Guo 1990[42] Frosolono1978[43]
	Medications that increase cAMP (aminophylline, dibutyryl adenosine 3,5 cyclic monophosphate [DbcAMP], Beta adrenergic agents)	Theoretical benefit when given early after exposure (no human data)	Sciuto 1997[44] Kennedy 1989[45]
	Ibuprofen	Reduction of pulmonary edema in rats (with pre and post exposure treatment)	Sciuto 1996[46]
	N-acetylcysteine	Reduction of pulmonary edema, lipid peroxidation, and leukotriene production in rabbits	Sciuto 1995[47]

VESICANT OR BLISTER AGENTS

BACKGROUND

Blister agents were developed and used during the First World War as chemical warfare agents.[48,49] These agents can be used in multiple forms to include liquid, solid or gas. Blister agents are generally broken down into sulfur mustard, nitrogen mustard, and Lewisite. Although used in different concentrations and in different forms, currently sulfur mustard is the most common blister agent used on the battlefield.

Sulfur mustard has three different main forms: HD, which is a distilled product and is close to 100% pure; H, which is undistilled sulfur mustard; and HT which is a mixture of HD and T (a thickener which can be added to sulfur mustard). HD or pure mustard is clear and smells of garlic. H sulfur mustard can be clear, yellow, red brown or black depending on the chemical mixture. In recent conflicts, to include the conflict with ISIS, H sulfur mustard is the chemical seen on the battlefield. This substance, made in crude chemistry labs, is a thick oily black substance which degrades quickly, only lasting 2-3 weeks in storage before degrading beyond utility.

Nitrogen mustard is much less commonly used as a chemical warfare agent. It is separated into 3 forms: N1, N2, and N3. Nitrogen mustard can have different smells with N1 smelling more like fish, N2 like fruit, and N3 like bitter almonds. Nitrogen mustards are clear to yellow oily substances that evaporate slowly and can harm first responders by contact or off-gassing from injured victims. Used for medicinal purposes such as chemotherapy or wart removal, these agents have so far never been used on the battlefield.

Lewisite is the last vesicant in this family of chemical agents. Related to arsenic, Lewisite is a clear liquid in pure form and amber or black in impure forms. Like the other vesicants, it is extremely irritating to the skin, eyes and respiratory tract. Lewisite can be mixed with HD for a more potent chemical warfare agent with properties from both substances. Unlike the other vesicants, Lewisite is the only vesicant that has an antidote to counter its systemic effects.

SIGNS AND SYMPTOMS OF VESICANT OR BLISTER AGENTS

The most common route of exposure of all blister agents is via the skin. Sulfur mustard agents will cause chemical burns associated with blisters within a few hours of contact with the skin or mucous membranes. Effects are not seen immediately on contact, but sulfur mustard is absorbed within minutes of contact on the skin or eye membranes. Second and third degree burns develop over 2-10 hours to the eyes and skin, causing intense pain, corneal perforations, erosions of the eyes, and blistering of all exposed skin. HD had a 2-3% mortality rate during WWI, but burns in excess of 25% body surface can be fatal. Nitrogen mustard has similar effects on the skin and eyes as sulfur mustard. However, Lewisite has immediate effects on the skin and eyes causing immediate pain and irritation and blistering much sooner than HD or nitrogen mustard.

Inhalation or ingestion of these vesicants causes similar problems, damaging the mucosa of both the respiratory and digestive systems, causing severe burns. Liquid agents, which are more concentrated, cause more severe damage than vapors which might be inhaled. Much like skin and eye exposure, inhalation of HD has a delayed effect on the respiratory tract, causing wheezing and swelling of the bronchioles several hours after exposure. As with skin symptoms, Lewisite causes respiratory symptoms much faster, usually within seconds to minutes, which then rapidly progresses to pulmonary edema following exposure.

Several late effects can occur from all blistering agents depending on the dose and the route of exposure of the agent. Bone marrow suppression can occur with increased likelihood of infection, and nitrogen mustard will cause anemia. High doses of sulfur mustard can cause convulsions and hyper-excitability. High doses of Lewisite can lead to hepatic necrosis, acute renal failure, and shock via capillary leaking, referred to as “Lewisite Shock.” There are many long-term effects suspected such as malignancies, corneal scarring, chronic respiratory disease, and dermal scarring.

DECONTAMINATION OF VESICANT OR BLISTER AGENTS

Safety of the rescuers and healthcare providers is the most important initial step when handling mustard casualties. First responders should have respiratory and skin protection during initial treatment of mustard

casualties. Butyl rubber is the recommended level of protection for the hands; however, double layers of nitrile gloves will protect against exposure as well. Remember, contaminated patients may appear innocuous due to delayed onset of symptoms, however providers can still be exposed to significant injury to the lungs, eyes, and skin if not properly protected. The casualty must be decontaminated and all clothing and equipment removed; vesicants enter the body within minutes, but can stay on equipment or clothing for days after exposure.

Removal of the agent must occur within three to five minutes in order to reduce absorption. Removal with a dry cloth is the first step to clear the chemical from the skin, followed by RSDL. There is no antidote for vesicants like there is for nerve agents, so initial treatment is focused on rapid decontamination. Exposure to the eye causes faster absorption than skin and should be washed out immediately with water in order to minimize the effects. Eye wash kits with Morgan Lens can facilitate eye decontamination. It is important not to induce vomiting if there is any concern for ingestion, and activated charcoal has not been shown to be effective in these situations. After decontamination, standard burn care treatment is recommended for all dermal injuries. Fluid replacement may not follow the thermal burn estimates; however, urine output remains a good marker of adequate resuscitation and fluids should be titrated to target a urine output of 30-50 ml/hour.

Wounds which are chemically contaminated should be aggressively flushed and treated as if there is heavy contamination. Mustard enters the body systemically almost immediately after exposure to open wounds or mucus membranes. After initial decontamination, the patient should be transported to a hospital and observed for both systemic and local effects of the contaminated wound. Surgical debridement of open wounds will almost always be required for contaminated wounds.

VESICANT OR BLISTER AGENTS DIAGNOSTICS

There is no readily available test to confirm vesicant exposure. Leukocytosis is anticipated on the first day and will rise with the amount of associated injury. Subsequently, bone marrow suppression occurs and leukocyte count will fall around day 3 to 5 with a nadir seen around day 9. Counts less than 500 indicate a poor prognosis. Chest X-ray can be used to monitor for pneumonitis, which typical appears in the first 2 to 3 days.

TREATMENT OF VESICANT OR BLISTER AGENTS

For asymptomatic patients exposed to sulfur mustard and nitrogen mustard, the effects may be delayed for skin, eye, and lungs; therefore, observation of potential exposures for 6-10 hours is recommended.

Patients with eye exposure may benefit from regular application of an anticholinergic ophthalmic ointment to prevent synechiae formation. A topical antibiotic/steroid ointment should be applied every 1-2 hours with rapid referral to an ophthalmologist. Ointment application to the lids prevents them from sticking together and can help prevent adhesions while allowing drainage of any underlying infection or pus. Blepharospasm can be treated with topical anesthetics to facilitate the eye exam, and systemic analgesics should be given for ongoing eye pain.

Table 7. Vesicant or Blister Agent Intervention

Agent	Intervention	Highlights	References
Sulfur Mustard[50]	Corticosteroids	Limited animal studies, immunosuppression may be detrimental	Wigenstam 2012 [53]
Nitrogen Mustard[51, 52]	Antioxidants and scavengers (Vitamin E, N-acetyl cysteine [NAC], glutathione, sodium thiosulfate)	Limited animal studies	Vojvodic 1985 [54] Anderson 2000 [55]
	Filgrastim/pegfilgrastim	Burns >25% Body Surface Area(BSA) with bone marrow suppression	Anderson 2006 [56]
	Amifostine	May provide protection prophylactically (animal studies)	Vijayaraghavan 2001[57,58]
Lewisite	British Anti Lewisite (BAL)/Dimercaprol	Chelation agent with significant side effects	Vilensky 2003 [59, 60]

If patients have respiratory symptoms hours after the exposure, they should be treated as chemical pneumonitis; albuterol should aggressively be utilized, and invasive airway management should be considered early in the treatment plan if the patient is not responding to albuterol. Systemic steroids have been recommended if albuterol is not effective, but further immune suppression may not be advisable. Inhaled sodium bicarbonate has been suggested as a possible treatment as well, but there is not robust evidence to support its use. Other antioxidants and scavengers such as sodium thiosulfate have shown some benefit in animal studies, but there is no human data to support their use. These therapies should only be considered in patients' refractory to supportive care when the benefit of unproven therapy outweighs potential risks.

Bone marrow suppression usually peaks around 9-10 days. Granulocyte colony stimulating factor analogues may be administered. Severe bone marrow suppression may be an indication for bone marrow transplant.

The antidote for Lewisite is British Anti-Lewisite (BAL), also known as Dimercaprol. BAL should only be used in a hospital setting and is given as an IM injection. BAL is a chelating agent, but due to the possibility of severe acute renal failure and other side effects, BAL is only recommended for patients who have severe respiratory symptoms or Lewisite shock.

Table 8. Vesicant or Blister Agents

<table>
<tr><td colspan="2">Vesicant
Lewisite (L)
Mustard-Lewisite Mixture (HL)
Immediate Acting Agent!</td><td><u>AGENT PROPERTIES</u>
Oily Liquid
Persistent, Freezing pt:
0.4°F/13°F
M8 Paper: Red to Pink
LCD: Red or Orange H
AP4C: AS, L, SA / S, H, HL
Odor: Geraniums</td><td><u>PPE REQUIREMENTS</u>
MOPP 4 (Mask w/ AP-PPE, JLIST, or UIPE)

<u>LETHALITY</u>
LCt50: 1,200 mg-min/m³
LD50: 30-50 mg/kg (skin)</td><td><u>CRESS SYMPTOMATIC PRESENTATION</u>
C: Conscious
R: Immediate Irritation, Distress
E: Immediate Severe Pain, Blepharospasm, Edema
S: Normal to Increased
S: Immediate Pain, Erythema, Blisters hours later
Other: Systemic Effects - Distributive Shock</td></tr>
<tr><td>POI HOT ZONE</td><td colspan="2">Immediate Action: Self Aid, Buddy Aid, Move (Upwind, Upstream, Uphill) Away from Threat
M²: Massive hemorrhage / Mask check
A²: Airway (assess) / Antidote (no antidote for vesicants in hot zone)
R²: Respiration (assess) / Rapid Spot Decon (RSDL, M295, Fibertect)
E: Extraction (egress away from threat)</td><td>Lewisite binds to tissues and absorbs systemically within two minutes of contact. Symptoms begin to manifest immediately upon exposure and worsen over time. Control of massive hemorrhage and rapid spot decon are top priorties.</td></tr>
<tr><td colspan="4">Extraction to the Dirty CCP [For Small Spills (< 2 kg) move away 100m day/300m night] [Large Spills (< 25kg) = 500m day/1000m night]</td></tr>
<tr><td>Dirty CCP WARM ZONE</td><td colspan="2">M² A² R² Reassessment, O_2 as needed, maintain filtered air, clear airway, albuterol inhaler, invasive airway if not responding to albuterol, pain management
Decon & Cutout:
▪ Remove and bag equipment, PPE, and clothing
▪ Wipe away gross contamination, RSDL cut line, Cut out
▪ RSDL residual contamination on skin (>2min contact time, then wipe away)
▪ Remove and replace contaminated treatments (tourniquets, chest seals, etc)
C²: Circulation (assess vitals, resuscitate) / Countermeasures (rapid decon, irrigate eyes and wounds with water)
H²: Hypothermia (prevent) / Head wounds (assess mental status--altered due to agent, or TBI?)
E: Evacuation</td><td>Casualties with palm-size exposure without rapid decon, >5% BSA burn, pulmonary edema, or shock symptoms with rapid onset require chelation. Early pain control may be required to ensure casualty cooperation. Administration of BAL within 5 minutes of exposure to skin and eyes can neutralize agent. <u>TIC/TIM Eye Injury Tx Protocol</u> may be required.</td></tr>
<tr><td colspan="4">Dirty Evacuation to Decontamination MSS or Evacuate Directly to Medical Treatment Facility if Field Decontamination is Sufficient</td></tr>
<tr><td>COLD ZONE</td><td colspan="2">(MARCHE)² Reassessment
M²: Convert tourniquets & bandage wounds
A²: In case of severe inhalation symptoms upgrade airway adjunct & RSI
R²: Vesicant Inhalation Tx SOP, Ventilator, O_2 , PEEP, Suction, Bronchoscopy
C²: Trend Vitals, TXA, FDP, FWB, Fluid Challenge if Req'd / severe exposures will present with distributive shock requiring chelation therapy with Dimercaprol aka British Anti-Lewisite (BAL) in order to resolve
H²: Hypothermia (HPMK, fluid warmer) / Head wounds (treat elevated ICP, Neuro exam, MACE)</td><td><u>Dimercaprol (BAL) Administration</u>
Initial Dose: 3 mg/kg deep IM repeat every 4 hours for two days
Then: Every 12 hours for 7-10 days
Severe & Life Threating Exposure: consider 5 mg/kg
Side Effects: Increased BP, Tachycardia, Nausea/vomiting, Headache, Anxiety, Injection Necrosis
Contraindications: Nut Allergy. Alternate Drug: DMSA
PFC: Pain Management, Expect SIRS and ARDS in cases of severe exposures.
Skin: Burns-apply Silvadene & bandage QID (burn fluid resuscitation not necessary)
Blister fluid may contain Arsenic, unroof >2cm, irrigate, calamine or steroidal cream
Eyes: Petroleum based ophthalmic ointment, possible iristis, ophthalmology consult</td></tr>
<tr><td colspan="4">Reachback: USAMRICD (410) 436-2230 DSN: 584-2230</td></tr>
</table>

INCAPACITATING AGENTS

BACKGROUND

Incapacitating agents produce temporary physical and/or mental effects that result in the inability of the affected individual to continue in their current duties or activity. Often they are described as non-lethal agents, but if administered in high enough doses, incapacitating agents can results in death or serious morbidity. There are three general categories of incapacitating agents:[61]

1. Anticholinergics

BZ (3-quinuclidinyl benzilate) is the prototypical anticholinergic agent but other anticholinergic agents may be developed for warfare. The British reportedly have a similar agent known as Agent 15. BZ is a centrally acting anticholinergic agent that was originally developed as a gastrointestinal antispasmodic but due to severe central nervous system effects was abandoned as a pharmaceutical. As an incapacitating agent, it has a very high safety profile due to the relatively lower peripheral antimuscarinic effects when compared to atropine. An effective incapacitating dose is 0.5 mg, and BZ is typically dispersed as an aerosol or in smoke-producing munitions.

2. Sedating agents

Opioids and volatile anesthetics are both potential sedative or calming agents. Fentanyl is a synthetic opioid with 100 times the potency of morphine. Newer derivatives of fentanyl are continuously in development. One such example is carfentanil with a potency 100 times fentanyl. While these agents are highly effective in individuals, aerosolizing them to use as an incapacitating agent can be problematic. It is likely that absorption in a crowd would be variable.

3. Riot control agents

Riot control agents, also known as harassing agents, cause irritation and discomfort often in the form lacrimation, mucous membrane irritation, violent coughing, or vomiting. Typical agents include chloroacetophenone (CN) commonly known as Mace, chlorobenzylidene malononitrile (CS), oleoresin capsicum (OC) called pepper spray, and diphenylaminochloroarsine (DM) or Adamsite. CN is more harmful than the other agents with a lower LCt50 and DM tends to cause vomiting.

Table 9. Incapacitating Agents

<table>
<tr><td colspan="2">Incapacitating Agents (Anticholinergics, Opioids, Riot control agents)</td><td><u>AGENT PROPERTIES</u>
Variable, aerosol, smoke or liquid M8 Paper: not useful</td><td><u>PPE REQUIREMENTS</u>
Mask and AP-PPE, JLIST, or UIPE

<u>LETHALITY</u>
Variable (fentanyl derivatives extremely potent)</td><td><u>CRESS SYMPTOMATIC PRESENTATION</u>
C: varies with agent, see below
R:
E:
S:
S:</td></tr>
<tr><td>POI HOT ZONE</td><td colspan="3">Immediate Action: Self Aid, Buddy Aid, Move (Upwind, Upstream, Uphill) Away from Threat
M²: Massive hemorrhage / Mask check
A²: Airway (assess) / Antidote (Cyanokit)
R²: Respiration (assess) / Rapid Spot Decon

E: Extraction (egress away from threat)</td><td>Recognize CRESS symptoms:
Anticholinergics-Delirium, agitation; red, hot and dry skin, mydriasis, tachycardia
Opioids - Sedation; decreased respirations, miosis, normal skin and secretions
Riot control agents - mucous membrane irritation (salivation, rhinorrhea and lacrimation, intact mentation)</td></tr>
<tr><td>Dirty CCP WARM ZONE</td><td colspan="3">M² A² R² Reassessment, O_2 as needed, maintain filtered air
Decon & Cutout:
▪ Remove and bag equipment, PPE, and clothing
▪ Wipe away gross contamination, RSDL cut line, Cut out
▪ RSDL residual contamination on skin (>2min contact time, then wipe away)
▪ Remove and replace contaminated treatments (tourniquets, chest seals, etc.)
C²: Circulation/Countermeasures/Drips (benzodiazepines, naloxone)
Hypothermia (prevent) / Head wounds (assess mental status--altered due to agent, or TBI?)</td><td>Anticholinergics – titrate benzodiazepines to control severe agitation, delirium
Opioids - Support respiration if needed. Naloxone (2-4 mg) if respiratory depression. May require escalating doses for some synthetic opioids</td></tr>
<tr><td>COLD ZONE</td><td colspan="2">(MARCHE)² Reassessment
C²: Circulation (Vitals/Fluid Challenge)
Countermeasures, Chelators, Drips
Anticholinergics – titrate benzodiazepines 2-4 mg IV/IO/IM
Opioids - Naloxone 2-4 mg IV/IO, titrate to respiratory effort
(May require naloxone drip (2/3 response dose/hour)
H²: Hypothermia (HPMK, fluid warmer / Head wounds
(treat elevated ICP, Neuro exam, MACE)</td><td colspan="2">PFC: supportive care
▪ Most agents are self-limited and symptoms will wear off, often as decontamination is performed. Look for reactive airway disease.
▪ Half-life of sedating agents may be longer than naloxone, so may require re-dosing or a drip
▪ Physostigmine can be used as diagnostic agent for anticholinergic delirium. Requires EKG with normal QRS prior to administration
▪ Benzos effective for seizures, agitation, and autonomic activity
▪ Sodium metabisulfite can neutralize CS</td></tr>
<tr><td colspan="5">Reachback: USAMRICD (410) 436-2230 DSN: (312) 584-2230</td></tr>
</table>

SIGNS AND SYMPTOMS OF INCAPACITATING AGENTS

Anticholinergics

BZ is intended to target CNS effects, therefore anticholinergic delirium will be the predominant symptom with fewer peripheral effects. Often the patient cannot give a lucid history due to delirium. The delirium may be labile and can range from mild impairment to coma. Hallucinations, severe agitation, and even seizures may occur. The classic peripheral effects often described a “dry as a bone, hot as a hare, red as a beet, and blind as a bat” may be variable or delayed.

Sedating agents

Sedating agents which are opioid derivatives can be expected to present with the classic opioid toxidrome of miosis, CNS depression, and respiratory depression. Bradycardia, hypotension, and hypothermia may occur as secondary sequelae as a result of dose-related progression to opioid coma.

Riot control agents

Riot control agents can be expected to affect the skin, respiratory system and eyes. Ophthalmologic symptoms include pain, tearing, and blepharospasm. The respiratory tract can be variably affected and

symptoms may range from mild mucous membrane irritation to severe dyspnea, coughing and chest tightness. Bronchospasm is common and may be severe in those with underlying reactive airway disease. Copious rhinorrhea and salivation may occur and clinical scrutiny is necessary to exclude the possibility of nerve agent exposure. Dermatologic effects typically involve skin pain and burning, but blistering may occur at higher doses.

GENERAL MANAGEMENT

Safe removal from exposure is the priority. Respiratory protection for providers in a potential exposure area is critical. Once the casualty is removed from the exposure area, decontamination can be continued with removal of all clothing and personal effects. Simple soap and copious water are adequate for through decontamination. Recognize that improvement in symptoms caused by riot control agents may be transient with decontamination.

Medical management of all incapacitating agents is predominantly supportive with attention to symptoms and tailoring treatment to the patient presentation.

ANTICHOLINERGIC AGENTS

Patients with anticholinergic toxicity can present with dry mouth and tachycardia leading the provider to believe dehydration is present when the patient is euvolemic. However, psychomotor agitation and hyperthermia are common so careful monitoring of core temperature, volume status and urine output is important. Cooling should be undertaken promptly when hyperthermia is present.

Pharmacologic managements include control of delirium and agitation. Agitation can be safely controlled with a benzodiazepine titrated to effect. Often controlling the agitation will also improve tachycardia and hyperthermia. Physostigmine is also an option to manage the delirium. This is a tertiary amine which crosses the blood-brain barrier. Before using physostigmine, it is critical to exclude the presence of other sodium channel blocking agents such as tricyclic antidepressants. An EKG should be done to ensure a normal QRS interval <100msec prior to physostigmine use, which limits its utility when EKG is not immediately available. Additionally, atropine should be ready in case there is a cholinergic response that affects the airway. In most cases, benzodiazepines are considered the primary treatment option since they can be administered safely to almost any patient.

SEDATING AGENTS

Support of the respiratory system is the primary focus for treatment of opioid toxicity associated with sedating agents. Naloxone is the antidote of choice and should be titrated to reverse respiratory suppression. Nasal naloxone can be rapidly administered without IV access. Naloxone should be titrated to effect. A starting dose of 2-4 mg is appropriate but much higher doses may be required to reverse the effects of synthetic opioids. The half-life of naloxone may be shorter than the half-life of the agent and repeat dosing or a naloxone drip may be necessary.

RIOT CONTROL AGENTS

Most riot control agents are short acting and supportive care is usually adequate until symptoms subside.

INCAPACITATING AGENT DIAGNOSTICS

Laboratory values are of little diagnostic utility. Opioids may be detected on routine toxin screen.

INCAPACITATING AGENT TREATMENT

Advanced interventions and the supporting evidence are described in the table below.

Table 10. Interventions for Incapacitating Agents

Agent	Intervention	Clinical Notes	References
Anticholinergic agents, BZ	Benzodiazepines	Control agitation and autonomic activity, seizure prevention/ treatment	Burns 2000[62]
	Physostigmine	Useful to reverse anticholinergic delirium, must have normal QRS on EKG, need atropine on hand if cholinergic crisis ensues	Burns 2000[62] Wetherall 2002[63]
Opioids	▪ Naloxone Initial dose of 2-4 mg followed by doubling escalating doses (4mg, 8mg, 16 mg) ▪ Narcan drip at 2/3 response rate ▪ Recognize half-life of naloxone may be shorter than some agents so may need re-dosing	Extrapolated from pharmaceutical opioid experience	Boyer 2012 [64]
Riot control agents	Sodium metabisulfite	Neutralizes malononitrile (CS)	Schep 2015 [65]

ACRONYM DEFINITIONS

ACLS: Advanced Cardiac Life Support
AP4C: Handheld Chemical Decontamination Device
AP-PPE: All-purpose Personal Protective Ensemble
ARDS: Acute Respiratory Distress Syndrome
CANA: Convulsive Antidote Nerve Agent
CCP: Casualty Collection Point
Cl: Chlorine
COCL2: Phosgene
CRESS: Consciousness, Respirations, Eyes, Secretions, Skin
CWA: Chemical Warfare Agents
DMSA: Dimercaptosuccinic Acid
FDP: Freeze-dried Plasma
FWB: Fresh Whole Blood
HPMK: Hypothermia Management Kit
ICP: Intracerebral Pressure

IDLH: Immediately Dangerous to Life or Health

JLIST: Joint Lightweight Integrated Suit Technology

LCD: Lightweight Chemical Detector

LCt50: Lethal Concentration, 50%;

LD50: Lethal Dose, 50%

MDI: Metered Dose Inhaler

MACE: Military Acute Concussion Evaluation

MOPP: Mission Oriented Protective Posture

MSS: Mission Support Site

NS: Normal Saline

PEEP: Positive End Expiratory Pressure

PFC: Prolonged Field Care

PPE: Personal Protective Equipment

RSDL: Reactive Skin Decontaminant Lotion

SIRS: Systemic Inflammatory Response Syndrome

TBI: Traumatic Brain Injury

TIC: Toxic Industrial Chemical

TIM: Toxic Industrial Material

TXA: Tranexamic Acid

UIPE: Undergarment Integrated Protective Ensemble

USAMRICD: US Army Medical Research Institute of Chemical Defense

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APPENDIX A: ATROPINE/SCOPOLAMINE PROTOCOL

Items Needed for One Casualty

(2) Vials 0.4mg/mL Scopolamine
(1) 3mL syringe
(1) 18ga hard needle
(1)250 mL Bag of NS.
(3) Vials 8mg/20mL Atropine
(1) Micro drip dial-a-flow.
(1) Pressure Infuser
(1) FAST One IO device w/ Flush or IV access kit

Preparation

If anticipating Nerve/Organophosphate/Carbamate exposed patients:

Prep Scopolamine as follows:

1. Draw 0.8mg (2mL) of scopolamine from the 0.4 mg vials into one 3mL syringe.
2. Leave syringe complete with a capped 18 ga needle so that it is ready for rapid administration.
3. Label syringe conspicuously with "SCOPE 0.8mg/2mL"

Prep Atropine drip bag as follows:

1. Add 50 mL of 8mg/20mL Atropine to 250 mL bag of NS.
2. Bag is now 20 mg/300mL. Ensure no air is in the bag as the extra 50 mL may barely fit.
3. Conspicuously mark bag w/ "ATROPINE 20mg/300mL approx. 1mg/3min"

Administration

After the administration of 3 ATNAA and 1 CANA IM assess patient and if not improved, administer scopolomine (preferred) OR atropine per the following protocols:

- If inadequate response to 3 ATNAA and 1 CANA, administer 0.8mg Scopolamine hydrobromide via IV/IO and flush. IM as a secondary.

OR

- Give bolus dose atropine in escalating doses every 3-5 minutes. Start with 2mg followed by 4mg, 8mg, 16mg.
- Once symptom control is achieved, start an atropine drip prepared as outlined above with a dose rate at 10% of the bolus dose (including the 6mg of atropine in the 3 initial ATNAAs) per hour.
- If a rebolus is required to control recurrent symptoms, then increase the drip to 20% of the initial response dose.
- Scopolamine 0.8mg is approximate to Atropine 10mg when calculating the initial response dose.
- A drip rate to 300 mL/hr this will administer approximately 1mg of atropine every 3 min.

Note: This protocol is intended to use as a starting point for providers who do not routinely use these medications. The protocol should be reviewed by physicians supervising non-licensed providers. This protocol does not supersede the clinical judgement of the responsible provider.

Sequence of actions in nerve agent exposure should be as follows:

- 3xATNAA
- 1xCANA
- IO access
- 2gTXA (if concomitant trauma)
- 500mg 2PAM IO/IV push (15-20 min improvement)
- 0.8mg scopolamine IO/IV
- Atropine 2mg IO/IV followed by doubling escalating doses q3-5min
- (if no change in mental status even if dry/atropinized) Midazolam 10mg for subclinical seizures
- 2 PAM drip IV

Naloxone:

- Initial dose of 2-4mg followed by doubling escalating doses (4mg, 8mg, 16mg)
- Narcan drip at 2/3 response rate

APPENDIX B: PRALIDOXIME (2-PAM) DRIP PROTOCOL

Pralidoxime (2-PAM) Drip Protocol

**given after 1800mg IM Injection (3 ATNAAs) if symptoms persist.*

1. Reconstitute 1 gram 2-PAM with 20mL of sterile water
2. Add 10mL 2Pam (500mg) to 100 mL Bag of NS and infuse over 5 minutes
3. Prepare continuous infusion by mixing 1 gram (20mL reconstituted) in 100mL bag of NS which will provide a 10mg/mL solution. Can also prepare 10 grams in 1L NS for a 10mg/mL solution.
4. Begin continuous infusion at 10mg/kg/hr.

APPENDIX C: PULMONARY AGENTS INHALATION INJURY TREATMENT PROTOCOL

Pulmonary Agents Inhalation Injury Treatment Protocol

Symptom relief for cough and wheezing/reactive airways

Albuterol nebulize 2.5mg in 3mL
Can combine with 3mL 4% or 2% lidocaine (for cough / pain suppression prn)
only use lidocaine in alert casualty

Note: The following treatments do not have robust evidence to support use but may be considered in patients with moderate to severe symptoms that are refractory to supportive care.

Nebulized Bicarbonate + N-acetylcysteine (NAC)

3mL 4.2% Bicarb (1.5 mL 8.4% diluted in 1.5mL Sterile Water) combine w/ 3mL NAC (for acidic inhalation, do not mix with other drugs or use if non-acidic inhalation)

Albuterol + NAC

Albuterol 2.5mg in 3mL combined with 3mL NAC (may repeat q 4-6 hrs)

Corticosteroids

Inhaled (can nebulize or use inhalant device) :
Budesonide 0.5mg-2.0mg BID
or
Fluticasone 200mcg BID

Administration via IV/IO:
Dexamethasone 8mg IV/IO q6hrs
or
Solu-medrol 125mg IV/IM q6hrs

APPENDIX D: EYE INJURY TREATMENT PROTOCOL

Toxic Industrial Chemical/Toxic Industrial Material/Vesicant Eye Injury Treatment Protocol

Tetracaine Eye Drops for Pain

1. 20 min normal saline flush with Morgan's Lens (LR is appropriate for Acids)
2. Ophthalmic antibiotic ointment to prevent eyelids from sticking shut
3. Allow eyes to drain. Avoid tight bandaging.

APPENDIX E: SEVERE VESICANT INHALATION PROTOCOL

Severe Vesicant Inhalation Protocol

- Mustard symptoms will be delayed, if severe airway complications arise it will most likely be during PFC. Lewisite injury will be immediate.
- Deep Tracheal Suctioning, Bronchoscopy, RSI, and Mechanical Ventilation also may be required.
- IV/IO 8mg Dexamethasone (preferred) or 125 mg Solu-Medrol
- Albuterol + NAC + Lidocaine

  Combine in a nebulizer q 4-6 hrs:

  (1) Albuterol bullet, 2.5mg in 3mL ,

  (2) NAC 20%, 3mL

  (2) Lidocaine 4% or 2%, 1 mL

Complications & Adverse Effects: Lidocaine can create an airway protection issue if casualty has altered level of consciouisness.

There is a potential for pneumonitis to develop after vesicant lung injury. Antibiotics (azithromycin, levofloxacin or moxifloxacin), should be used in the setting of suspected infection and not prophylactically

APPENDIX F: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Chemical, Biological, Radiological and Nuclear (CBRN) Injury Part I: Initial Response to CBRN Agents (CPG ID: 69)

This guideline is intended for use in conjunction with Tactical Combat Casualty Care (TCCC) guidelines as an organized approach to the care of chemical, biological, radiological and nuclear (CBRN) casualties in the deployed environment.

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INTRODUCTION

This Role 1 (including Point of Injury [POI]) through Role 3 Clinical Practice Guideline (CPG) is intended for use in conjunction with Tactical Combat Casualty Care (TCCC) Guidelines. This CPG is meant to provide medical professionals who encounter CBRN exposures with evidence-based guidance where it exists or consensus opinion when evidence is lacking. This CPG is divided into 4 sections:

1. Response to CBRN agents (an approach to all CBRN casualties)
2. Medical management of chemical agent exposure
3. Medical management of radiation exposure and nuclear events
4. Medical management of biologic agent exposure

While encountering conventional casualties on the battlefield remains a more likely scenario, vigilance is necessary for unusual scenarios that might represent the first clue that a CBRN incident occurred. Since environmental sampling for agent detection and rapid point-of-care testing for agent identification will not be routinely available in austere environments or most hospital settings, the initial suspicion of a CBRN attack will rest on clinical recognition of signs and symptoms of poisoning. This guideline is intended to provide an approach to casualty assessment and treatment from POI to established medical facilities.

BASIC PRINCIPLES OF CBRN CASUALTY MANAGEMENT

Initial care of the CBRN casualty should be approached in the same manner as other casualties. Life threats require prompt recognition and intervention, and non-life-threatening sequelae can be addressed when clinically appropriate. Early recognition and categorization of CBRN-exposed patients is the foundation for further management, and is key not only for initiating patient treatment but also for preventing contamination of medical personnel, equipment, and facilities. Thorough and appropriate decontamination is a core skill that requires planning and practice. Attention to details such as preventing hypothermia in patients undergoing decontamination and clinical reassessment at each stage of the process will reduce unnecessary morbidity. Basic life saving measures such as airway management and resuscitation are fundamental concepts that must be mastered at the appropriate level for each practitioner in the CBRN care chain. Furthermore, easy access to reference materiel to guide advanced therapy should be a part of every provider's armamentarium. These basic principles will be discussed in more detail in the sections that follow.

CRITICAL TASK LIST

The critical task list is applicable to both medical and non-medical personnel. All personnel should be trained on the concepts and principles identified in the critical task list in order to respond to CBRN casualties. The critical task list addresses core competencies that can be adjusted based on the medical skill level of the responder. These tasks should be trained according to service-specific publications and recognized standards of medical care.

- Recognize CBRN exposure that requires action to protect self and others
- Don personal protective equipment (PPE) to prevent exposure in self and assist others with PPE
- Egress from the threat
  - Move upwind, uphill, upstream from threat
  - Utilize time/distance/shielding for protection

- Recognize signs/symptoms of CBRN exposure that prompt immediate self-treatment or treatment of others (i.e. nerve agent exposure)
- Apply TCCC integrated with CBRN response TCCC + CBRN = (MARCHE)[2]

  Massive hemorrhage/mask, airway/antidote, respiration/rapid spot decontamination, circulation/ countermeasure, hypothermia/head injury, extraction/evacuation
- Apply airway management skills in a CBRN setting (positioning, suction, ventilation to include manual and mechanical, placement of definitive airway)
- Perform Rapid Spot Decontamination
- Identify and establish Hot/Warm/Cold Zones
- Establish a dirty casualty collection point (CCP)
- Understand decontamination principles and casualty procedures for partial or complete removal of PPE, clothing, and equipment (casualty cut out)
- Understand cross contamination and take appropriate measures to prevent it
- Understand available technology that can aid in agent identification

PLANNING CONSIDERATIONS

The response to CBRN exposure requires extensive planning based on the threat. In a high-threat environment, immediate availability of adequate PPE is essential. Personnel should also be aware of field expedient PPE options. (Table 1)

Table 1. Examples of Military-issued PPE

Examples of PPE –Military Issued	
Respiratory	• M50 Joint Service General Protective Mask (JSGPM) • M61 filter, C2A1 canister • M40/ M45, M53 Mask
Skin	• Joint Service Lightweight Integrated Suit Technology (JSLIST) Chemical & Biological Protective Garment (24 hour protection) • All-purpose-Personal Protective Ensemble (AP-PPE) • Lion Extended Response Team (XRT) Suit (8 hours protection) • Butyl rubber gloves with cotton liner • Vinyl overboot

Table 2. Field Expedient PPE Alternative

Field Expedient PPE Options When CBRN-Specific Equipment Not Available	
Respiratory	Emergency Passenger Oxygen System (EPOS)
Skin	Nitrile gloves x 3
Equipment	6mm sheeting and bags

EVACUATION PLANNING CONSIDERATIONS

MEDICAL REGULATING

1. Military Treatment Facility (MTF)
   - DECON/Treatment Coordination. Ensure MTF is prepared to receive dirty casualties and determine the most appropriate location for DECON.
   - Treatment Capabilities (Toxicology, Critical Care, Trauma Surgery). Determine whether the MTF has the services necessary to care for and sustain the CBRN casualty on site and/or establish telemedicine support.
   - Capacity. The CBRN casualty is far more resource intensive than a typical trauma or critically ill casualty. Assess the MTF's capacity and capability to treat CBRN casualties and identify potential alternate locations.
2. Evaluation. Integrate the medical regulating system into CBRN exercise scenarios.

LANDING ZONE / CASUALTY EXCHANGE POINTS

1. Route coordination.
   Consider alternate routes, primary routes may be jammed or unavailable.
2. Environmental Considerations
   - Wind
   - Terrain / Slope
   - Drainage
   - Water sources

EVACUATION PLATFORMS

1. Clean and Dirty. It is necessary to plan for both clean and dirty platforms for evacuation.
2. Refuel. When planning evacuations, consider the time it takes for refueling in a MASCAL situation, as well as the distance from the objective to the DECON site and MTF. Also factor in any platform decontamination that may be necessary prior to arrival at the refueling site.
3. Aircraft/Vehicle DECON (Spot, Wash Down, Detailed). Based on the available assets, determine the time it will take to conduct each type of decontamination.
4. Preparation time (hasty vs. deliberate). Factor the time it takes to prepare the platform for a hasty or deliberate CBRN mission.
5. Evaluation. Integrate evacuation and handoff training into CBRN training exercises.

PROTECTIVE MEASURES

(allow for time required to install when planning)

1. Barrier (disposable; plan for additional on-hand quantities)
   - Preventive maintenance checks need to occur on a regular basis.
   - Consider time required for deliberate vs. hasty set-up.

- 6mm tarp and chemical or 100-mph tape for improvised

2. PPE (Pilots / Drivers / Crew)

CASUALTY CARE

Class VIII (medical supplies) and critical care support equipment:

1. Antidote and countermeasure resupply and additional stock (information on the CDC's Strategic National Stockpile can be found at https://www.cdc.gov/cpr/documents/dsns_fact_sheet.pdf)
2. Airway support / ventilation - anticipate need for advanced airway management and ventilators
3. Casualty Monitoring
   - Electronic vital signs monitoring
   - ETCO2
   - Hypothermia. Special emphasis must be placed on maintaining body temperature, as cut-out procedures will create greater exposure to environmental factors.

DECONTAMINATION

An extensive discussion of decontamination is outside the scope of this CPG, however basic decontamination principles are outlined below. (Figure 1)

1. Prevent further casualties by applying PPE before treating others.
2. Remove all clothing and equipment. Contain and dispose of contaminated material appropriately.
3. If radiologic exposure, cover wounds before further decontamination. Ensure gentle decontamination as radionuclide absorption may be increased if skin becomes erythematous.
4. Decontamination solutions
   a. Soap and water in copious amounts
      - Physical removal and dilution of agents
      - Does not destroy biological agents or neutralize radioactive particles
   b. 0.5% hypochlorite solution
      - Nine parts water to one part 5% bleach
      - Wipe on the skin and rinse with fresh water
      - Can be used in open wounds but do not use in chest or abdominal cavity (risk of adhesions), open brain or spinal cord wounds (unknown effects), or in the eyes (risk of corneal opacification)
   c. Reactive Skin Decontamination Lotion (RSDL)
      - Indicated for chemical agents and T-2 mycotoxin
      - Packaged sponge contains reactive agent that penetrates skin
      - Deactivates mustard (HD) and nerve agent

- Currently FDA-approved only for intact skin, not for wounds or eyes
- Best results occur when RSDL is applied immediately after exposure, gently scrubbed (agitated) on skin for two minutes, removed, and then reapplied (RSDL may be left on skin for up to 24 hours)

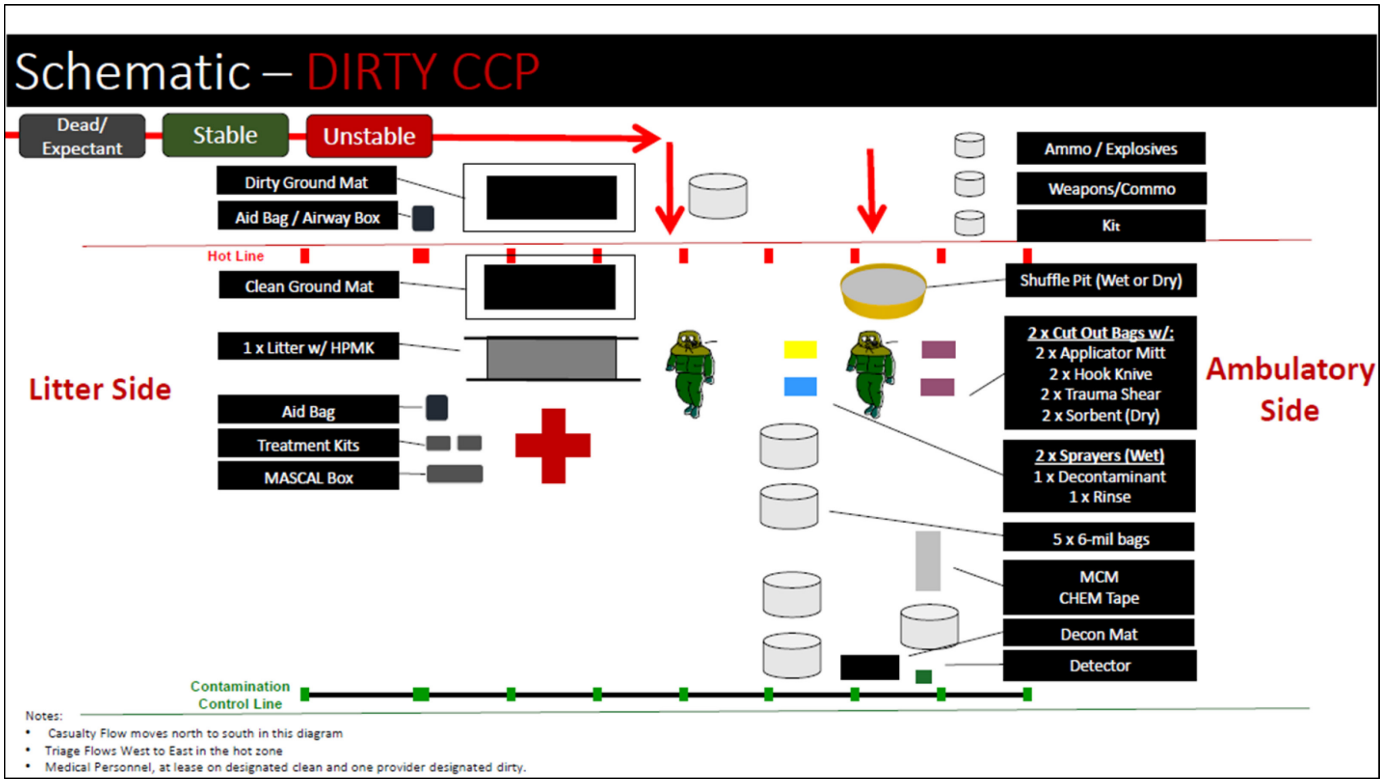
d. Surgical solutions for open chest and abdominal cavity wounds

e. Water, normal saline, or eye solutions are recommended for the eye

5. Standard infectious disease protective measures should be utilized for biological agents

6. Internal decontamination will be discussed in detail in the medical management of radiologic exposure and nuclear events

Figure 1. Casualty decontamination schematic.



Notes:

- Casualty Flow moves from top to bottom in this diagram
- Triage flows immediate to delayed from left to right in the hot zone diagram
- Medical personnel, at least one provider designated clean and one provider designated dirty

IDENTIFICATION OF AGENT

Agent identification is a critical step in determining casualty treatment. Recognize that intelligence reporting may be incomplete or inadequate. There are a variety of detectors that can aid in agent identification and providers should be familiar with the technology that is part of their organization.

Combine available intelligence, technology, and patient presentation to create a comprehensive picture for agent identification to help guide treatment. Mixed exposures are possible and correlating patient signs and symptoms with adjunctive agent identification techniques can help ensure the proper treatment is pursued.

** Casualty treatment should never be delayed pending confirmatory agent identification. Clinical assessment (using CRESS described below) is necessary to determine immediate therapy. Decisive efforts for agent identification can be done in parallel to timely medical treatment.**

TRIAGE AND EVACUATION PRIORITIES

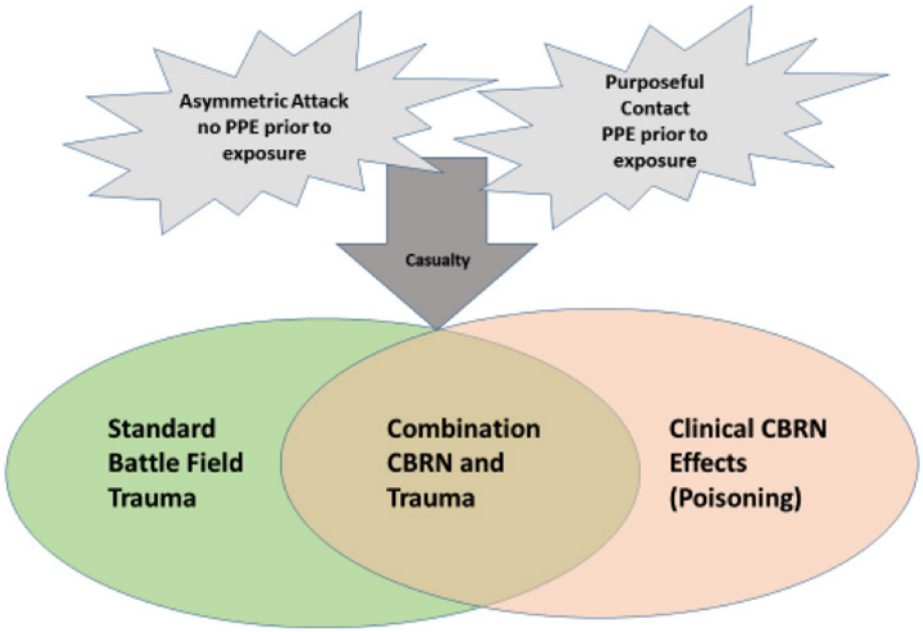
Because of the differences in casualty presentation for chemical, biological, radiological, and nuclear event casualties, specific triage recommendations and evacuation priority considerations will be addressed in the portion of the CPG that is specific to the categories of CBRN exposures.

Do not forget that CBRN exposure is an enemy attack and security will be the first priority to be coordinated. Then, triage for a CBRN event follows established triage principles, including doing the most good for the most people. Because of the complexity of combined CBRN and trauma casualties, it may be beneficial to assign an experienced provider to triage. Triage occurs for decontamination, for medical treatment, and for evacuation. Although placing casualties into one of two groups for assignment to ambulatory vs. non-ambulatory decontamination lanes is a kind of sorting, true triage for decontamination involves a determination of who can tolerate delays in decontamination. Decontamination order may be based on extent of exposure and not on initial symptoms, as symptoms may be delayed. Those with more extensive exposures may benefit from rapid decontamination to decrease their risk for later symptoms, and thus reduce the future burden on medical resources. Once decontaminated, patients are triaged according to medical priority. Decontamination is a medical intervention (it minimizes or eliminates the conversion of an external dose to an internal dose), and any casualty with an area suspicious of having been exposed to a liquid chemical agent is automatically medically triaged as immediate until immediate (local, spot) decontamination has been accomplished. The casualty is then re-triaged. Except for vesicant casualties, those exposed only to vapor can tolerate delays in decontamination or may not even require thorough decontamination. It is important to frequently reassess patients. Because many CBRN agents cause delayed symptoms, a casualty initially determined to be minimal may become immediate. (Ramesh 2010) Remember that the process of decontamination can significantly change the casualty status. It is critically important to monitor for hypothermia, disruption of previously controlled bleeding, and other changes in patient status that would change triage priority.

TACTICAL COMBAT CBRN CASUALTY CARE +CBRN

Assessment and management of CBRN casualties is complex because it involves not only life-threatening symptoms (some of them rapid onset) but also the threat of contamination of all first responders. An added source of complexity is the frequent mixing of CBRN and penetrating trauma injuries. (Figure 2) Working through this complexity involves a stepwise approach that first rules in or rules out CBRN injuries so that first responders can protect themselves if necessary before rendering aid. The next step integrates assessment and management of both CBRN and traumatic injuries, prioritizing the recognition and management of life-threats first.

Figure 2. CBRN Casualties.



CRESS: A SIMPLIFIED APPROACH TO CBRN CASUALTY ASSESSMENT

A tool to rapidly evaluate for CBRN injuries is the CRESS algorithm. (Table 2)

After using the CRESS algorithm to rule out or rule in a CBRN injury, and first responders donning PPE if present, the (MARCHE)[2] algorithm should be applied to evaluate for and manage CBRN and traumatic injuries.

Table 2. Chemical casualty assessment

C	**C**onsciousness (unconscious, seizures, depressed consciousness, agitation)
R	**R**espirations (present or absent, labored, increased or decreased)
E	**E**yes (constricted, dilated, normal)
S	**S**ecretions (dry, normal, increased)
S	**S**kin (diaphoretic, dry, hot, cyanosis)

Just as trauma casualties present differently (blunt, trauma, GSW, blasts, etc.), CBRN casualties also have varied presentations. For example, chlorine casualties will require more attention to the toxic inhalation symptoms contrasted with a mustard casualty whose associated trauma may require more prompt intervention than the mustard-specific effects. CBRN casualties can be categorized by circumstances of exposure and presence or absence of trauma and CBRN effects. The acronym CRESS (Consciousness, Respirations, Eyes, Secretions, Skin) is employed to improve rapid identification of the type of chemical agent exposure.

In a CBRN-threat environment, casualties may have traumatic, CBRN or mixed injuries. Before applying TCCC, it is important to identify whether CBRN injuries are present and identify a suspected agent to allow first responders to protect themselves before treating the patient. While this often can be deduced using intelligence reports, technologic agent identification resources, and circumstances of the CBRN event, there will be times when agent identification will need to be made solely based on clinical assessment of symptoms. Some CBRN agents, such as nerve agents, can be rapidly fatal; therefore, recognition of such symptoms is the equivalent of identifying massive hemorrhage in the trauma patient. Clinical clues can be aggregated to identify the most likely agent responsible for symptoms according to the CRESS assessment. Each letter in CRESS corresponds to physical exam findings that can be used to categorize the suspected agent based on the constellation of findings. CRESS findings associated with specific chemical agents are shown in Table 3.

Figure 3. The acronym CRESS

The acronym CRESS is used to differentiate exposures to chemical agents. Exposure to biological agents is unlikely to cause early symptoms. Radiologic exposure may lead to early onset of symptoms (<1 hour post exposure) such as nausea, vomiting, diarrhea, and fever with high dose exposures (>6 Gray). CRESS findings for select chemical agents are summarized in Table 3.

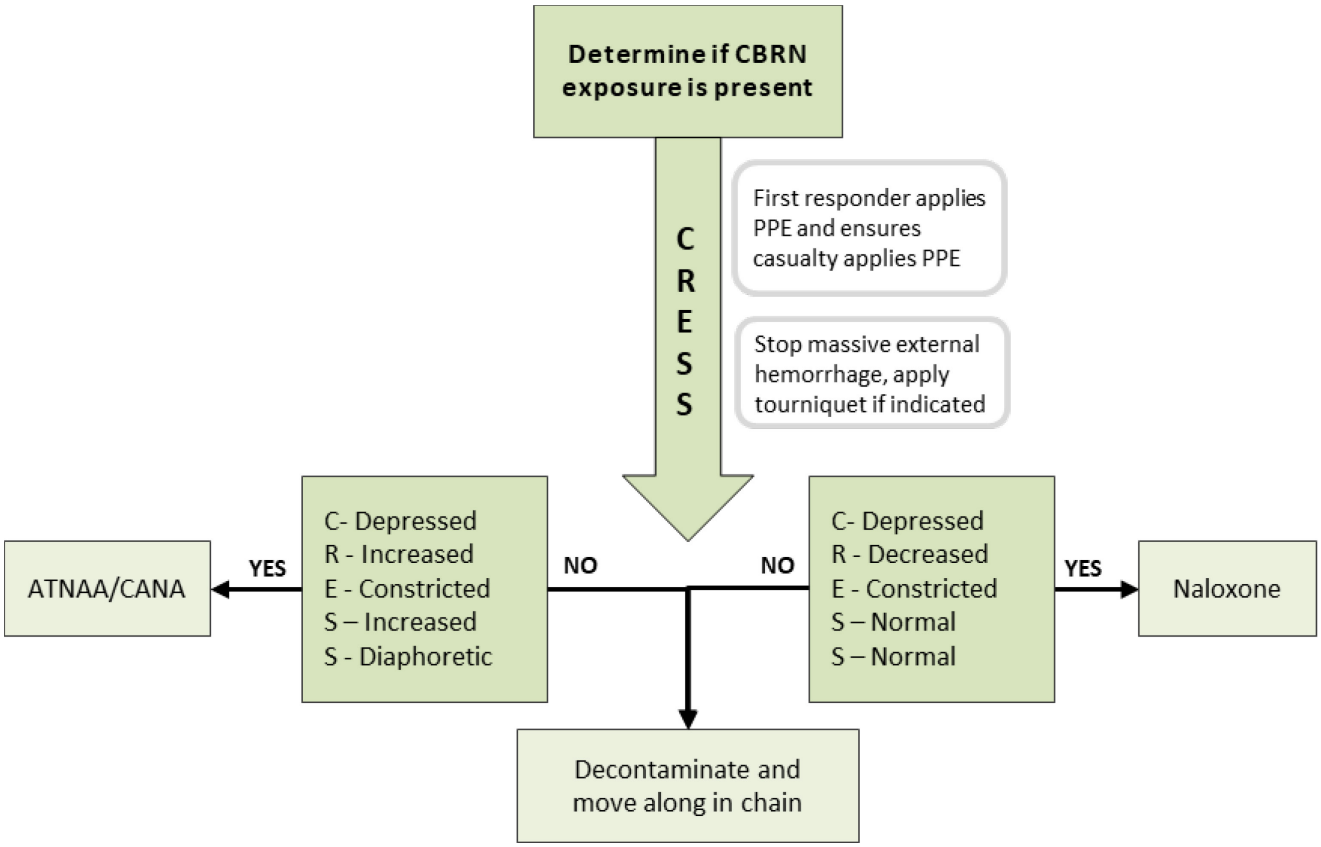


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Table 3. CRESS finding for select chemical agents.

Agent	Consciousness	Respirations	Eyes	Secretions	Skin
Nerve	Depressed consciousness or unconscious	Increased	Constricted (Miosis)	Increased (lacrimation, rhinorrhea, salivation, bronchial secretions)	Diaphoretic
Cyanide	Depressed consciousness or unconscious	Increased	Normal	Normal	May be flushed or cyanotic when advanced shock
Chlorine Phosgene (delayed effects)	Normal (unless asphyxia causes loss of consciousness)	Increased	Normal	Increased (Lacrimation, rhinorrhea, salivation) Delayed fluid in lungs	Normal
Vesicants	Normal	Increased if vapor	Normal	Increased (lacrimation, rhinorrhea, salivation) Delayed fluid in lungs at very high doses	Normal initially
Opioid Incapacitating agent	Depressed consciousness or unconscious	Decreased	Constricted (Miosis)	Normal	Normal
Anticholinergic Incapacitating agent	Agitated	Normal or increased	Normal or dilated (mydriasis)	Decreased	Dry and hot
Riot control agents	Normal	Normal or increased	Normal	Lacrimation, rhinorrhea, salivation.	Normal

(MARCHE)^2: INTEGRATING TCCC MARCH WITH CBRN FIRST RESPONSE

After initial assessment of casualty in CBRN-threat environment for the presence or absence of CBRN symptoms using the CRESS algorithm (and donning of PPE by first responders if present), the integrated assessment and management of TCCC and CBRN injuries can proceed.

The acronym (MARCHE)^2 integrates these two processes using the established TCCC MARCH algorithm (Massive Hemorrhage, Airway, Respirations, Circulation, Hypothermia) with CBRN priorities of Mask, Antidotes, Rapid spot decontamination, Countermeasures, Extraction and Evacuation. Combining these two approaches gives the acronym (MARCHE)^2 or "MARCH-squared."

Similar to TCCC, (MARCHE)^2 can be broken into phases of care from highest threat (care under fire or active CBRN threat), to intermediate threat (tactical field care or warm zone casualty management), to lowest threat (PFC/evacuation or care of decontaminated casualties in cold zone). Figure 4 below.

Figure 4. (MARCHE)²

MARCHE: Massive hemorrhage/Mask, Airway/Antidote, Respiration/Rapid spot decontamination, Circulation/Countermeasure, Hypothermia/Head injury, Extraction/Evacuation. CRESS: Consciousness, Respirations, Eyes, Secretions, Skin.

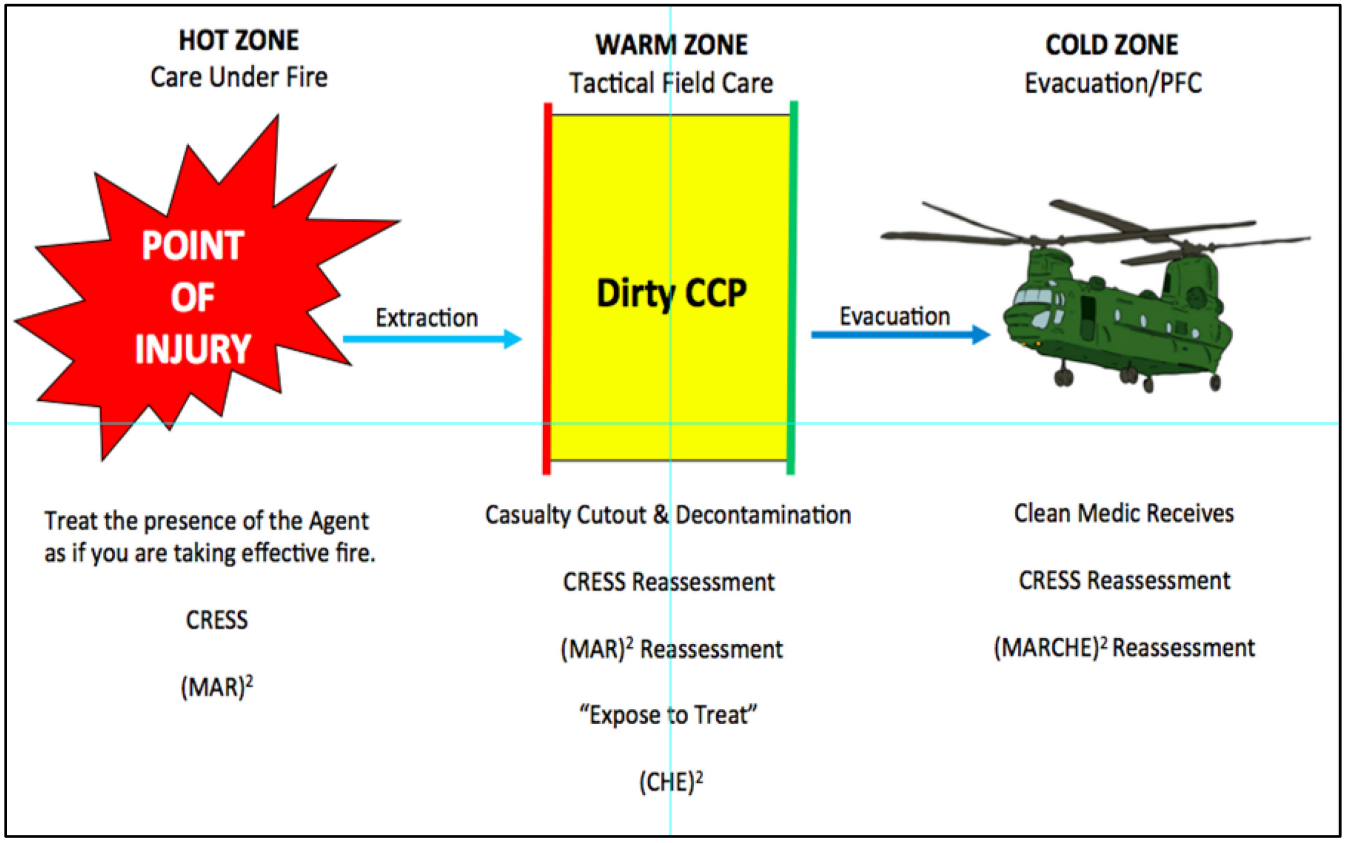
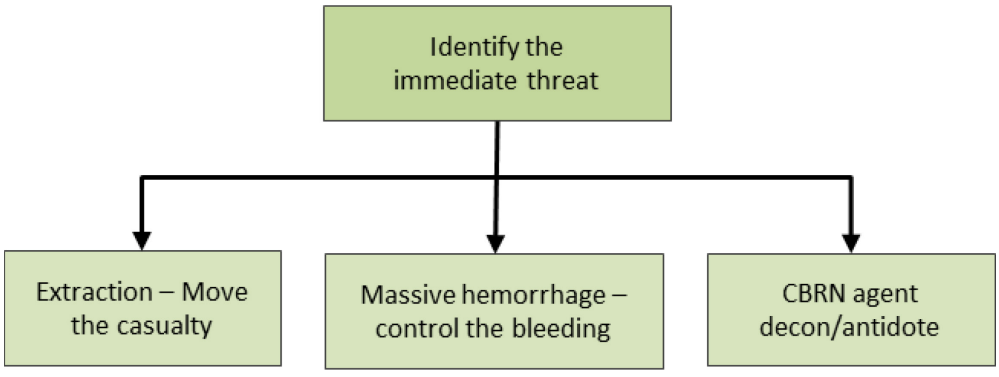


Figure 5. Hot Zone/Care under fire immediate threats.


Identify the immediate threat
Extraction – Move the casualty
Massive hemorrhage – control the bleeding
CBRN agent decon/antidote

PUTTING IT ALL TOGETHER, INTEGRATING CRESS AND (MARCHE) [2]

Step 1: Hot Zone / Care Under Fire

During "hot zone" care, the agent itself is similar to enemy fire. As such, the priorities are protection from and egress away from the threat (CBRN agent) for both casualty and provider. Both casualty and provider should don protective mask. If the casualty is incapacitated, the provider must ensure the casualty's protective gear is applied and functional.

Only rapid interventions for immediate life-threats should be addressed. Massive hemorrhage, if present, may be the most immediate life threat and control of hemorrhage supersedes other interventions. Massive hemorrhage, if compressible, should be treated according to TCCC guidelines with limb tourniquets.

Perform a rapid assessment of the airway and respirations. Excessive secretions and increased respirations may indicate nerve agent exposure. Completion of the CRESS assessment will help determine if the symptoms are due to trauma or chemical agent exposure. Most airway and respiration interventions should be deferred. Occasionally, such interventions may take priority over mask application, but the decision to unmask a casualty in order to provide the intervention needs to be weighed against the risk of the contaminated environment.

Some CBRN agents are rapid killers. The CRESS assessment will quickly determine whether immediate antidotes are required. If nerve agent exposure is suspected (decreased level of consciousness, increased respirations, constricted pupils, increased secretions, diaphoretic skin) then the provider should direct self-administration of Antidote Treatment Nerve Agent Auto-injector (ATNAA) and Convulsant Antidote for Nerve Agent (CANA) or administer the antidotes for an incapacitated casualty.

Rapid spot decontamination of skin or wounds is indicated when there is gross contamination on the skin or wounds or when protective gear is breached. If wound contamination with chemical agent is suspected, immediately expose the wound to perform rapid spot decontamination. This step is necessary even in a contaminated environment and may be lifesaving.

Treatment for cyanide can be considered in the hot zone, but the need to establish IV/IO access to administer hydroxocobalamin makes this a judgment call weighed against the time needed to reach the warm zone and the ongoing threat in the hot zone location. Naloxone 2 mg intramuscular or intranasal for opioid incapacitating agents may also be considered for life-threatening respiratory depression. As in TCCC, non-essential interventions should be deferred until the next phase of care.

Table 4. Point of Injury (Hot Zone) Response– (M A R)².

Point of Injury (Hot Zone) Response– (M A R)²	
TCCC	**CBRN**
Massive Hemorrhage	**Mask**
Stop life-threatening external hemorrhage if tactically feasible: • Direct casualty to control hemorrhage by self-aid if able. • Use a CoTCCC-recommended limb tourniquet for hemorrhage that is anatomically amenable to tourniquet use. • Apply the limb tourniquet over the uniform clearly proximal to the bleeding site(s). If the site of the life-threatening bleeding is not readily apparent, place the tourniquet "high and tight" (as proximal as possible) on the injured limb and move the casualty to cover.	• Don mask • Help casualty don mask or ensure proper seal if mask already in place. • Ensure Powered Air Purifying Respirator (PAPR) or Self Contained Breathing Apparatus (SCBA) is functional.
Airway	**Antidotes**
• Assess (excessive secretions may indicate nerve agent exposure) • Airway management is generally best deferred	• Antidotes are given in the Hot Zone if the casualty has symptoms of poisoning. • These agents are rapid killers: - Nerve agent (give ATNAA, CANA). - Cyanide (give hydroxocobalamin). - Pharmaceutical based sedating agent (give naloxone)
Respiration	**Rapid Spot Decon**
• Assess: normal, shallow, labored, absent? (increased respirations may indicate nerve agent exposure) • Complete the CRESS assessment and determine if caused by the agent or trauma • Respiratory intervention is generally best deferred	• At the point of injury, physical removal of the agent/rapid spot decontamination is indicated if agent can be seen on the skin, if there is suspicion of wound contamination by agent, or if there is a breach in the suit. • Apply RSDL, M100, M295, Sorbent, tech wipe, etc.
Extraction	
Egress away from the threat	

Step 2: Warm Zone / Tactical Field Care

In the warm zone, or tactical field care phase, attention is given to decontamination and reassessment of the casualty. This phase occurs at a dirty CCP (hotline) and requires personnel dedicated to triage, decontamination, and patient treatment. At this phase, interventions may have altered the clinical presentation of the casualty (e.g., the patient may have decreased secretions and reduced airway resistance from use of the ATNAA), so it is important to take into account prior interventions and changes in the clinical status of the casualty. However, the goal is to quickly transition the casualty to the cold zone for definitive care, so only life-saving treatments should be done in the warm zone.

Decontamination and treatment can be synchronous processes. Medical personnel will need to clearly communicate with non-medical personnel responsible for decontamination. "Expose to treat" is used by decontamination personnel when the provider deems it in the best interest of the casualty to remove PPE to provide life-saving medical intervention. For example, the mask may be removed and the head, face, and chest quickly decontaminated so that the provider can ventilate the casualty and insert a sternal IO if parenteral

antidotes, blood product or fluid resuscitation or countermeasures are immediately indicated. It would also be appropriate to prioritize decontamination of an arm to establish an IV or proximal humerus IO access.

Circulation should be assessed to identify external hemorrhage and shock. The provider can assess the effects of both CBRN agents and antidotes on the patient's circulatory status. As decontamination ensues, dirty treatments are replaced with clean. Due to cold water and the need to fully expose the casualty in order to conduct thorough decontamination, hypothermia is a significant risk. Ensure rapid transit through the decontamination line with careful attention to hypothermia mitigation in order to prevent iatrogenic injury from the decontamination process. Additionally, personnel working within the warm zone in full protective gear are at risk of heat injury and stressors associated with operating in PPE, which must be recognized and mitigated

Table 5. Assessment at the Dirty CCP (Warm Zone)– (M A R C H E)²

<table>
<tr><th colspan="2">Assessment at the Dirty CCP (Warm Zone)– (M A R C H E)² Treat life-threats ONLY</th></tr>
<tr><th>TCCC</th><th>CBRN</th></tr>
<tr><td colspan="2">Reassess: Are immediate life threats addressed?</td></tr>
<tr><td>M.A.R. Reassessment (Massive hemorrhage, Airway, Respirations)
• Stop all external hemorrhage
• Advanced airway as indicated
• Treat tension pneumothorax
• Ventilator support (positive end expiratory pressure support, pressure monitoring)</td><td>M.A.R. Reassessment (Mask, Antidote, Rapid spot decon)
• Check mask seal
• Assess response to antidote and reassess CRESS
• Reassess need for rapid spot decon</td></tr>
<tr><th>Circulation</th><th>Countermeasures</th></tr>
<tr><td>• Pulse Check
• Skin Check
• Assess for Shock
• Fluid resuscitation per TCCC guidelines only if absent radial pulse
• IV/IO access if needed immediately</td><td>• Nebulized or inhaler-administered medications such as albuterol or corticosteroid (hand-held inhaler for conscious casualty and in-line options for unconscious casualty)
• IV/IO Drips (hydroxocobalamin, atropine, naloxone, etc.)
• Suction the airway (bulb syringe likely not adequate, recommend mechanical suction)
• Treat life-threats ONLY
• Specific countermeasures may be found in CBRN CPG Part II.</td></tr>
<tr><th colspan="2">Hypothermia</th></tr>
<tr><td colspan="2">• Package the casualty.
• Protect from lethal triad: Hypothermia, acidosis, and coagulopathy</td></tr>
<tr><th colspan="2">Head Wounds (Altered Mental Status)</th></tr>
<tr><td colspan="2">Determine whether casualty's altered mental status is due to chemical agent or trauma</td></tr>
<tr><th colspan="2">Evacuation</th></tr>
<tr><td colspan="2">• Determine Evacuation Priority
• Fill out Casualty Card
• Move patient for further decontamination or to evacuation platform.
• The Dirty CCP may be far from the point of injury, necessitating exhausting casualty carries and exposing rescuers to heat injury from the burdens of PPE.</td></tr>
</table>

Step 3: Cold Zone / Tactical Evacuation Care / Prolonged Field Care

Once the decontaminated casualty has passed into the cold zone, they should be re-evaluated and receive needed interventions to include tactical evacuation or prolonged field care. The decontamination process alone can result in significant change in the casualty's condition, so re-triage and reassessment are the first priority. If a secondary survey has not been performed, it should be done immediately after re-assessment of the primary survey. Documentation throughout the phases of care is vital to facilitate information transfer as the patient transits from one phase to another. The CBRN casualty card (Appendix B) is a useful tool to ensure comprehensive documentation relevant to the CBRN casualty. In the absence of a CBRN casualty card, the TCCC casualty card is sufficient if duration of care before transfer is short and patient is relatively stable. If handoff to higher echelon of care is delayed or patient is unstable, PFC documentation will likely be necessary. (Loos 2018)

It is important to take into consideration that receiving providers at all roles of care may have minimal to no experience with CBRN patients. Communication is crucial to ensure receiving providers understand previous decontamination and care and exposures that may be suspected. This can prevent delays in patient care caused by unnecessary repetitive decontamination or redundant treatments.

Casualties that reach the cold zone have been decontaminated and are now suitable for the full spectrum of care appropriate to the clinical environment and capabilities. There are however, some unique concerns to address in a combination CBRN/trauma casualty. While thorough decontamination and complete removal of a casualty's clothing eliminates almost all debris, it is possible the casualty may have retained foreign material or contaminated dressings in wounds. Such material may pose risk to treating personnel from off-gassing or secondary contamination. Additionally, this residual contamination may represent a continuing source of exposure to the patient via a route that bypasses the normal barriers of the skin resulting in rapid systemic distribution of the agent. Larger fragments should be removed from the wound using a "no touch" technique with surgical instruments, followed by placing the material and instrument in a sealed container with hypochlorite solution, minimizing the risk to providers. When possible, the contaminated wound should be further irrigated with clean water. Providers dealing with contaminated foreign material or dressings can wear 3 pairs of nitrile gloves. The outer glove should be discarded every 20 minutes. In the absence of suspected retained debris, the fully decontaminated patient in the cold zone can be treated as all other patients at that level of care. The extent of wound care provided will depend on prehospital resources available and transport time to surgical care.

EVACUATION CONSIDERATIONS

The en route care approach to the combined CBRN/trauma casualty should not differ from POI through TACEVAC. The $(MARCHE)^2$ mnemonic provides a helpful methodology for assessing and applying critical interventions during transport. The medical provider should perform regular reassessments, recheck all $(MARCHE)^2$ interventions, and intercede where necessary; prioritizing those interventions that are life-saving. In general, physical examination capabilities are degraded during transport. These challenges are amplified in the CBRN environment when the medical provider and crew are wearing PPE. Training while in MOPP IV and practicing patient care maneuvers that may be hindered by this protective posture is paramount to successful care of the CBRN casualty.

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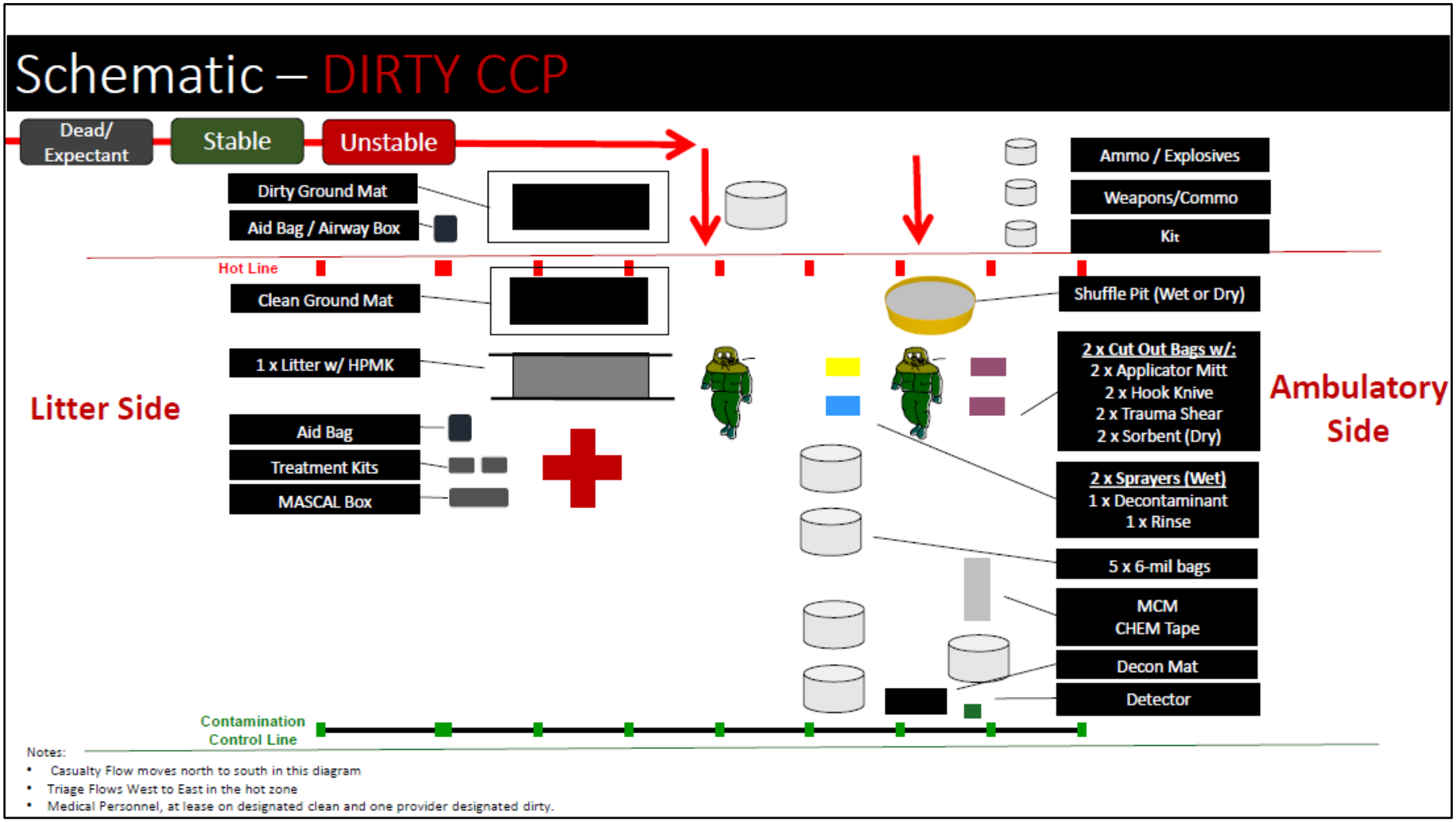
APPENDIX A : (MARCHE)^2 SUMMARY

TCCC + CBRN = (MARCHE)^2			
	Hot Zone	**Warm Zone**	**Cold Zone**
Priorities	• Think Care Under Fire, sometimes agent is like effective fire • "What is killing the casualty now, is it the agent or trauma?" The answer to this question dictates your treatments • Triage • Treat only immediate life-threats • Expose only what is needed to save life. • CRESS assessment. Identify nerve agent exposure. • If chemical contamination of a wound is suspected, expose perform rapid spot decontamination as soon as possible • Protect yourself and the casualty from the threat: time, distance, shielding, upwind, uphill, upstream • Heat injury from operating in PPE is common and may be unrelated to the agent. • Getting to the warm zone may require prolonged movement of the casualty. • A medic caring for chemical casualties is contaminated (dirty medic) and cannot cross to cold zone with patient until decontaminated. • In conventional TCCC, only massive hemorrhage is addressed during CUF. However, some chemical agents are rapid killers. Nerve agent antidotes and rapid decontamination must be administered as early as possible.	• Think Tactical Field Care • "What is killing the casualty now, is it the agent or trauma?" The answer dictates your treatments • Triage • Provide only life-saving care, get them to the cold zone for definitive care. • Replace dirty tourniquets and decontaminate indwelling devices or replace as indicated. • Casualty may require advanced airway management and ventilator support • Perform cutout and thorough decontamination. • Perform treatments while decontamination is being conducted. "Expose to treat". • Assess circulation and administer resuscitation fluids per TCCC guidelines only if absent radial pulse • Countermeasures: administer specific treatments for life-threats as needed based on exposure and symptoms • Hypothermia is a threat due to exposure during decontamination. • Determine whether altered mental status is due to chemical agent or trauma	• Think Tactical Evacuation or Prolonged Field Care • "What is killing the casualty now, is it the agent or trauma?" The answer to this question dictates your treatments. • Triage • Anticipate and mitigate hypothermia. • Receiving medical personnel may have little to no experience with CBRN. Ensure effective patient handoff. • Clean Medic (remains on cold zone side of hot line and not exposed to contaminated casualties)
TCCC	M: Massive Hemorrhage	M.A.R.: reassessment	(MARCHE)^2 reassessment
	A: Airway, assess	C: Circulation and Shock Status	
	R: Respirations, assess	H: Hyperthermia, H: Head Wounds (altered mental status	
	E: Extraction	E: Evacuation	
CBRN	M: Don Mask, Mask check	M.A.R.: reassessment	(MARCHE)^2 reassessment
	A: Antidote (ATNAA/CANA)	C: Countermeasures (drips, nebulized medicines, etc.)	
	R: Rapid Shot Decontamination	H: Hyperthermia, H: Head Wounds (altered mental status	
	E: Extraction	E: Evacuation	

Terms: (MARCH)^2: Massive hemorrhage/Mask, Airway/Antidote, Respiration/Rapid spot decontamination, Circulation/Countermeasures, Head/Hypothermia, Extraction/Evacuation
TCCC: Tactical Combat Casualty Care; CBRN: chemical, biological, radiological, nuclear; CRESS: Consciousness, Respirations, Eyes, Secretions, Skin PAPR: Powered Air Purifying Respirator; SCBA: Self Contained Breathing Apparatus; ATNAA: Antidote Treatment Nerve Agent Auto-injector; CANA: Convulsant Antidote for Nerve Agent

APPENDIX B: CASUALTY DECONTAMINATION SCHEMATIC



Source: CBRN MED = (MARCHE) 2, The Tactical Medic's Approach to the Poisoned and Traumatically, Devin DeFeo 18D, FP-C, NREMT-P, http://www.specialoperationsmedicine.org/Documents/2017%20SOMSA/2017%20Presentations/24May17%201300%20UW-FID%20CBRNE%20Threat%20in%20Current%20AO.pdf

APPENDIX C: CASUALTY CARE CARDS

TACTICAL COMBAT CASUALTY CARE (TCCC) CARD

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

NAME (Last, First): _____ LAST 4: _____

GENDER: ☐ M ☐ F DATE (DD-MMM-YY): _____ TIME: _____

SERVICE: _____ UNIT: _____ ALLERGIES: _____

Mechanism of Injury: (X all that apply)

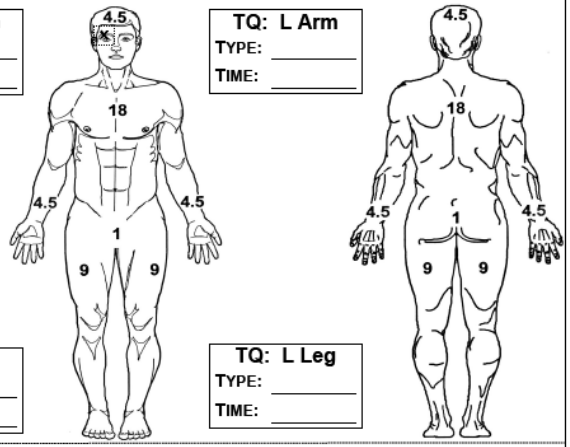
☐ Artillery ☐ Blunt ☐ Burn ☐ Fall ☐ Grenade ☐ GSW ☐ IED

☐ Landmine ☐ MVC ☐ RPG ☐ Other: _____

Injury: (Mark injuries with an X)

TQ: R Arm
TYPE: _____
TIME: _____

TQ: L Arm
TYPE: _____
TIME: _____



TQ: R Leg
TYPE: _____
TIME: _____

TQ: L Leg
TYPE: _____
TIME: _____

Signs & Symptoms: (Fill in the blank)

	Time			
Pulse (Rate & Location)				
Blood Pressure	/	/	/	/
Respiratory Rate				
Pulse Ox % O2 Sat				
AVPU				
Pain Scale (0-10)				

DD Form 1380, JUN 2014 TCCC CARD

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

Treatments: (X all that apply, and fill in the blank) *Type*

C: TQ- ☐ Extremity ☐ Junctional ☐ Truncal _____

Dressing- ☐ Hemostatic ☐ Pressure ☐ Other _____

A: ☐ Intact ☐ NPA ☐ CRIC ☐ ET-Tube ☐ SGA _____

B: ☐ O2 ☐ Needle-D ☐ Chest-Tube ☐ Chest-Seal _____

C:	*Name*	*Volume*	*Route*	*Time*
Fluid				
Blood Product				

MEDS:	*Name*	*Dose*	*Route*	*Time*
Analgesic (e.g., Ketamine, Fentanyl, Morphine)				
Antibiotic (e.g., Moxifloxacin, Ertapenem)				
Other (e.g., TXA)				

OTHER: ☐ Combat-Pill-Pack ☐ Eye-Shield (☐ R ☐ L) ☐ Splint

☐ Hypothermia-Prevention Type: _____

NOTES:

FIRST RESPONDER

NAME (Last, First): _____ LAST 4: _____

DD Form 1380, JUN 2014 (Back) TCCC CARD

Source: JTS. https://jts.health.mil/assets/docs/forms/DD_Form_1380_TCCC_Card_Jun_2014.pdf

Appendix C: Casualty Care Cards (continued)

CBRN CASUALTY CARD

Name:_____

NERVE	ATNNA AUTO INJECTOR (2mg Atropine, 600mg 2Pam										
NERVE	CANA AUTO INJECTOR (10mg Diazepam)										
NERVE	ATROPINE AUTO INJECTOR (AtroPen 2mg) or (Drip 2-5mg every 3-5 min)										
NERVE	SCOPOLAMINE 0.8mg IV/IO										
NERVE	2 PAM CHLORIDE 1g IV over 30 min, repeat over 30 min if severe										
TOXIC INHALTION CHLORINE MUSTARD INHALATION	TICS/TIMS PROTOCOL in steps (Albuterol, 1 bullet / 2cc 2% lidocaine / 2cc 4.2% Bicarb given alone) Dexamethasone 8mg IV q 6hr										
CYANIDE	CYANOKIT (Hydroxycobalimin IV) One Dose: 5gm / 15 min reconstituted in 100ml NS per vial										
CYANIDE	SODIUM THIOSULPHATE 25% 12.5g IV Given after Cyanokit, different line										
Cyanide/Organophosphate Ingestion	ACTIVATED CHARCOAL 50g Adlt, 1g/kg Kids										
STRONTIUM 90	ALUMINUM PHOSPHATE (MYLANTA/MAALOX) 100ml PO										
CESIUM 137	RADIOGARDASE 500mg/tab (PRUSSIAN BLUE) DOSE 3gm PO tid										
PU 238-239, URANIUM, COBALT 60	Ca-DTPA 1gm/5ml in 250ml NS over 30 min										
PU 238-239, URANIUM	Zn-DTPA 1gm/5ml in 250ml NS over 30 min										
HF	CALCIUM GLUCONATE 3 gm IV Nebulized 2.5% w/O2 for inhalation or CALCIUM CHLORIDE 1gm IA										
URANIUM	SODIUM BICARBONATE 50 mEq/ 50 ml, new line/no mix										
OPIATE OD	Narcan 0.4-2mg IV slow push over 2min. Drip rate 2/3 of reversal dose per hour.										

Source: CBRN MED = (MARCHE) 2, The Tactical Medic's Approach to the Poisoned and Traumatically, Devin DeFeo 18D, FP-C, NREMT-P, http://www.specialoperationsmedicine.org/Documents/2017%20SOMSA/2017%20Presentations/24May17%201300%20UW-FID%20CBRNE%20Threat%20in%20Current%20AO.pdf

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Crush Syndrome - Prolonged Field Care (CPG ID: 58)

This Role 1 prolonged field care (PFC) guideline is meant to provide medical professionals who encounter crush syndrome in austere environments with evidence-based guidance for how to manage the various aspects of crush injury care and monitoring.

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INTRODUCTION

This Role 1 prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines when evacuation to higher level of care is not immediately possible. A provider of PFC must first and foremost be an expert in TCCC. This CPG is meant to provide medical professionals who encounter crush syndrome in austere environments with evidence-based guidance for how to manage the various aspects of crush injury care and monitoring. Recommendations follow a "minimum," "better," "best" format that provides alternate or improvised methods when optimal hospital options are unavailable.

Crush syndrome is a life and limb-threatening condition that can occur as a result of entrapment of the extremities accompanied by extensive damage of a large muscle mass. It can develop following as little as 1 hour of entrapment. Effective medical care is required to reduce the risk of kidney damage, cardiac arrhythmia, and death.

Crush syndrome is a reperfusion injury that leads to traumatic rhabdomyolysis. Reperfusion results in the release of muscle cell components, including myoglobin and potassium that can be lethal. Myoglobin release results in rhabdomyolysis, with risk of kidney damage. Kidney damage leads to hyperkalemia and eventually cardiac arrhythmias. Calcium is taken up by injured muscle cells and this can cause hypocalcemia, contributing to cardiac arrhythmias. The risks are increased with large areas of tissue crushed (one or both lower extremities) and the length of time the casualty is pinned prior to extrication.

The primary treatment is aggressive fluid administration. Reperfusion after prolonged tourniquet application (>2 hours), extremity compartment syndrome, and severe limb trauma involving blunt trauma can also result in rhabdomyolysis by the same mechanisms as crush syndrome, and the treatment is the same.

For feedback or additional input on this CPG, please visit PFCare.org .

Telemedicine: Management of crush syndrome is complex. Establish telemedicine consult as soon as possible.

FLUID RESUSCITATION

The principles of hypotensive resuscitation according to TCCC DO NOT apply in the setting of extremity crush injury requiring extrication.

However:

In the setting of a crush injury associated with noncompressible hemorrhage, aggressive fluid resuscitation may result in increased hemorrhage. Balancing the risk of uncontrolled hemorrhage against the risk of cardiotoxic levels of potassium should ideally be guided by expert medical advice (in-person or telemedicine).

FLUIDS[1–5]

Goal: Correct hypovolemia to prevent myoglobin injury to the kidneys and dilute toxic concentrations of potassium to reduce risk of kidney damage and lethal arrhythmias.

- **Best:** IV crystalloids
  Start intravenous (IV) or intraosseous (IO) administration IMMEDIATELY (before extrication).
  Rate and volume: initial bolus, 2L; initial rate: 1L/h, adjust to urine output (UOP) goal of >100–200mL/h (see below)
- **Better:** oral intake of electrolyte solution.
  Sufficient volume replacement may require "coached" drinking on a schedule.[6]
- **Minimum:** rectal infusion of electrolyte solution.
  Rectal infusion of up to 500mL/h can be supplemented with oral hydration.[6,7]

Life-threatening hyponatremia can result from large-volume administration of plain water. If using oral or rectal fluids because of unavailability of IV fluids or access, they must be in the form of a premixed or improvised electrolyte solution to reduce this risk.[6]

Examples of mixed or improvised electrolyte solutions include the following:

- World Health Organization (WHO) oral rehydration salts (ORS): preferred
- Pedialyte® (Abbott Laboratories, https://pedialyte.com)
- Per 1L water: 8 tsp sugar, 0.5 tsp salt, 0.5 tsp baking soda
- Per quart Gatorade® (Stokely-Van Camp Inc, www.gatorade.com): 0.25 tsp salt, 0.25 tsp baking soda

MONITORING

Goal: Maintain high UOP, detect cardiotoxicity, ensure adequate oxygenation and ventilation, avoid hypotension, trend response to resuscitation. Document blood pressure (BP), heart rate (HR), fluid input, urine output (UOP), mental status, pain, pulse oximetry, and temperature on a flowsheet.

Urine Output[8,9]

Goal: UOP of 100–200mL/h. The fluid rate should be adjusted to maintain this level of UOP.

- **Best:** place Foley catheter.
- **Minimum:** capture urine in premade or improvised graduated cylinder (e.g., Nalgene® bottle [Thermo Fisher Scientific, nalgene.com]).
- Maintain goal UOP until myoglobin can be monitored and normalized.

  If UOP is below goal at IV fluid rate of 1L/h for >2 hours, kidneys may be damaged and unable to respond to fluid resuscitation.
  Consider:

Teleconsultation, if available:

- Decreasing the fluid rate to reduce risks of volume overload (e.g., pulmonary edema)
- Hemorrhage or third spacing may cause hypovolemia.
  Consider: Increasing the fluid rate

URINE MYOGLOBIN[10–13]

Goal: Monitor for worsening condition

- **Best:** laboratory monitoring of urine myoglobin
- **Better:** urine dipstick monitoring of erythrocyte/hemoglobin (Ery/Hb)[10]
  Urine dipstick Ery/Hb will be positive in patients with myoglobinuria.
- **Minimum:** monitor urine color. Darker urine (red, brown, or black), either consistently or worsening over time, is associated with increasing myoglobinuria and increased risk of kidney damage.

HYPERKALEMIA AND CARDIAC ARRHYTHMIAS

Release of potassium from tissue damage and kidney damage can result in hyperkalemia (>5.5mEq/L), resulting in life-threating cardiac arrhythmias or heart failure[14–17]

Goal: Monitor for life-threatening hyperkalemia

- **Best:** laboratory monitoring of potassium levels, 12- lead electrocardiogram (ECG), cardiac monitor (e.g., ZOLL® [ZOLL Medical Corp, www.zoll.com]; Tempus Pro™ [Remote Diagnostic Technologies, http://www.rdtltd.com])
- **Better:** laboratory monitoring of potassium levels, cardiac monitor (e.g. ZOLL®, Tempus Pro™)
- **Minimum:** close monitoring of vital signs and circulatory examination
- **Frequency:** every 15 minutes for initial 1–2 hours
- Decrease frequency to every 30 minutes, then hourly if stable or if urine is clearing
- Monitor for premature ventricular contractions (PVCs; skipped beats), bradycardia, decreased peripheral pulse strength, hypotension
- Specific ECG signs: sinus bradycardia (primary sign); peaked T waves, lengthening PR interval (early signs), prolonged QRS interval, PVCs or runs of ventricular tachycardia, conduction block (bundle branch, fascicular)
- If PVCs become more frequent, the patient develops bradycardia, peripheral pulse strength decreases, or potassium levels are >5.5mEq/L or rising, treat urgently for hyperkalemia.
- Insulin and 50% dextrose (D50); calcium gluconate; albuterol (see treatment instructions below).
- Consider teleconsultation or more urgent evacuation to facility with laboratory and ECG monitoring, if possible.
- Use tourniquets to isolate limb(s). (See Tourniquets below.)

Treatments for Cardiac Arrhythmias Due to Hyperkalemia

Treat if potassium level is >5.5mEq/L or there are cardiac arrhythmias (see above). Note that a normal ECG may occur in patients with hyperkalemia.

Goal: Restore normal ECG/prevent fatal cardiac complications.

Treatment for Hyperkalemia

- **Best:** calcium gluconate; insulin + D50; albuterol; sodium polystyrene sulfonate
- **Better:** calcium gluconate; insulin + D50
- **Minimum:** any individual or combination of treatments, as available
- **Calcium gluconate (calcium replacement):** Increases serum calcium to overcome the effect of hyperkalemia on cardiac function.[18] Alternate: may use calcium chloride, which is more irritating when administered via peripheral IV.

  Treatment instructions: Administer 10 mL (10%) calcium gluconate or calcium chloride IV over 2–3 minutes. Onset of effect: immediate. Duration of action: 30–60 minutes.
- **Insulin and glucose:** Insulin is given to lower the serum potassium level by driving it back into the cells; glucose is given to prevent hypoglycemia.[18]

  Treatment instructions: Give 10 units of regular insulin followed immediately by 50mL of D50. Onset of effect: 20 minutes. Duration of action: 4–6 hours.
- **Albuterol:** Lowers serum potassium level by driving it back into the cells; effect is additive with insulin.[19]

  Treatment instructions: Administer 12mL of albuterol sulfate inhalation solution, 0.083% (2.5mg/3mL) in nebulizer. Onset of effect: 30 minutes. Duration of action: 2 hours.
- **Sodium polystyrene sulfonate (Kayexalate®; Concordia Pharmaceuticals,** http://concordiarx.com): Lowers serum potassium level by removing potassium from the gut.[18]

  Treatment instructions: 15–30g suspended in 50–100mL liquid. Oral or rectal. Onset of action: >2 hours. Duration of action: 4–6 hours.
- **Bicarbonate:** Although routinely recommended as mainstay treatment to reduce kidney damage by raising the urine pH and diminishing intratubular pigment cast formation, and uric acid precipitation; to correct metabolic acidosis; and to reduce potassium levels, there is no clear evidence that bicarbonate reduces kidney damage,[20] and the effect of reducing potassium is slow and unsustained.[21]

Sodium polystyrene sulfonate removes potassium from the body. All other treatments temporarily lower potassium by shifting it out of circulation and into the cells. Continue to monitor and repeat treatment when needed.

TOURNIQUETS FOR MANAGEMENT OF CRUSH

Tourniquets may delay the life-threating complications of a reperfusion injury if immediate fluid resuscitation or monitoring is not initially available. Consider tourniquet placement for crush injury before extrication if the length of entrapment exceeds 2 hours and crush injury protocol cannot be initiated immediately.[22–24]

Goal: Delay acute toxicity until after fluid resuscitation and monitoring are available.

- **Best:** Apply two tourniquets side by side and proximal to the injury immediately before extrication

- **Minimum:** Apply two tourniquets side-by-side proximal to the injury immediately after extrication
- Initiate crush injury protocol before loosening tourniquet, and then only if the patient meets criteria for tourniquet conversion or removal given in the TCCC guideline

A limb that is cool, insensate, tensely swollen, and pulseless is likely dead. Patient may develop shock and kidney damage, and may die. Consider fasciotomy. If no improvement, place two tourniquets side by side and proximal to the injury and do not remove. Amputation anticipated.

FASCIOTOMY

Extremity compartment syndrome must be anticipated with crush injury and reperfusion injury.[25–27]

Goal: Decompress muscle, restore blood flow.

- **Best:** Perform fasciotomy (only if there are clinical signs of compartment syndrome). The earliest sign is limb swelling with severe pain with or without passive motion, persisting despite adequate analgesia, followed by paresthesia, pallor, paralysis, poikilothermia, and pulselessness.

Only if qualified medical personnel or teleconsultation (ideally with real-time video capability) available.

  - Then only if wound care available.
  - Regional anesthesia with nerve block or IV sedation required.

- **Minimum:** Cool limb to reduce extremity edema (evaporative or environmental cooling only, do not pack limb in ice or snow because of risk of further tissue damage).
- **Pain management:** Refer to TCCC Guidelines for analgesia on the battlefield.[28]

INFECTION

For infection due to associated wounds and not crush injury itself, follow the Joint Theater Trauma System Infection Control Guidelines: "Prevent Infection in Combat-Related Injuries for Extremity Wounds."[29]

Goal: Prevent infection.

- **Best:** Ertapenem, 1 gm IV/day (1g, 10 ml saline or sterile water)
- **Better:** Cefazolin, 2g IV every 6 to 8 hours; clindamycin (300–450 mg by mouth three times daily or 600 mg IV every 8 hours); or oxifloxacin (400 mg/day; IV or by mouth)
- **Minimum:** Ensure wounds are cleaned and dressed, and hygiene of wounds and patient optimized to the extent possible given environment.

Two appendices accompany this article: Appendix A presents a summary of fluid and equipment planning considerations; Appendix B summarizes monitoring and management considerations relative to time.

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APPENDIX A: FLUID AND EQUIPMENT PLANNING CONSIDERATIONS

Best	▪ **Fluids:** IV fluid to provide 1L/h for 24 to 48 hours (depending on evacuation availability) ▪ **Equipment:** ECG, laboratory tests for serum potassium and urine myoglobin, Foley catheter with graduated collection system, tourniquets ▪ **Medications:** hyperkalemia*: calcium gluconate (5 x 10mL vial or Bristojet), insulin: 1 vial Humulin R (500 units; Lilly USA, www.humulin.com), D50 (120mL), albuterol (24 vials), Kayexalate (360g; Concordia Pharmaceuticals, http://concordiarx.com) ▪ **Pain:** refer to Analgesia, Sedation Clinical Practice Guidelines ▪ **Antibiotics:** Ertapenem ▪ **Monitoring:** Continuous monitoring with portable monitor; 15-minute to hourly vital signs, examination, urine output documented on flowsheet **Communications: real-time video telemedicine consultation**
Better	▪ **Fluids:** IV fluid to provide 1L/h for 24 to 48 hours ▪ **Equipment:** Dipstick urine tests to monitor urine, graduated container to monitor urine output, tourniquets ▪ **Medications:** hyperkalemia: calcium gluconate (5 x 10mL vial or Bristojet), insulin: 1 vial Humulin R (500 units), D50 (120mL) ▪ Pain medications ▪ Antibiotics ▪ **Monitoring:** 15-minute to hourly vital signs, examination, urine output documented on flowsheet **Communications: telephone, possibly e-mail telemedicine consultation**
Minimum	▪ Fluids: IV fluid for initial bolus resuscitation (2L), then oral or rectal fluid resuscitation with commercial or improvised electrolyte solution ▪ Equipment: Graduated container to monitor urine output, tourniquets ▪ Medications: hyperkalemia: calcium gluconate (5 x 10mL vial or Bristojet) ▪ Pain medications ▪ Antibiotics ▪ Monitoring: 15-minute to hourly vital signs, examination, urine output documented on flowsheet or other written format **Communications: telemedicine by telephone**

APPENDIX B: CRUSH INJURY, MONITORING AND MANAGEMENT CONSIDERATIONS

			Phase 1 Entrapment	**Phase 2** Extrication	**Phase 3** Immediately Following Extrication	**Phase** 4 Prolonged Field Care
FLUIDS						
	Best	IV or IO crystalloids	Initial bolus: 2L, continue 1L/h	Continue 1L/h	Titrate to UOP 100–200mL/h	Titrate to UOP 100–200mL/h
	Better	Oral electrolyte solution	Continue	Continue	Continue. Goal UOP 100–200mL/h	Continue. Goal UOP 100–200mL/h
	Minimum	Rectal electrolyte solution	Continue	Continue	Continue. Goal UOP 100–200mL/h	Continue. Goal UOP 100–200mL/h
Telemedicine: Consult on management						
Monitoring: 15-minute to hourly vital signs, examination, urine output documented on flowsheet						
VITAL SIGNS						
	Best	Portable monitor with ECG	Record every 15 minutes	Record every 15 minutes	Record every 15 minutes	Record every 1 hour
	Better	Check intermittent vital signs	Every 15 minutes	Every 15 minutes	Every 15 minutes	Record every 1 hour
	Minimum	Monitor pulse and mental status	Every 15 minutes	Every 15 minutes	Every 15 minutes	Record every 1 hour
UOP	Best	Place Foley catheter	N/A	N/A	Record UOP every 1 hour	Record UOP every 2 hours
	Minimum	Capture urine in premade or improvised graduated cylinder				
Urine myoglobinuria	Best	Laboratory monitoring	N/A	N/A	N/A	Every 6 hours
	Better	Assess urine color (red, brown, or even black)				
	Minimum	Dark urine (red, brown, or even black)				
Potassium and cardiac arrhythmia	Best	Laboratory monitoring of potassium levels	N/A	N/A	Check	Every 4-6 hours
		12-lead ECG	N/A	N/A	Check	Every 4-6 hours
	Better	Laboratory monitoring of potassium levels	N/A	N/A	Check	Every 4-6 hours
		3–5 lead ECG	Initiate	Continue	Continue	Continue
	Minimum	Close monitoring of vitals and circulatory examination	Initiate	Continue	Continue	Continue
Treatments for Hyperkalemia (>5.5mEq/L) or Cardiac Arrhythmia						
Calcium gluconate (10%)	Best	10mL IV over 2–3 minutes	N/A	N/A	Monitor; repeat as required	
Insulin (regular) and D50		10 units IV push + 50mL D50	N/A	N/A		
Albuterol (2.5mg/3mL vial)		10mg (4 vials) in nebulizer	N/A	N/A		
Sodium polystyrene sulfonate (Kayexalate)		15–30g suspended in 50–100mL liquid, oral or rectal	N/A	N/A		

			Phase 1 Entrapment	**Phase 2** Extrication	**Phase 3** Immediately Following Extrication	**Phase** 4 Prolonged Field Care
Calcium gluconate 10% Alternate: calcium chloride 10%	Better	10mL IV over 10 minutes				
Insulin (regular) and D50		10 units IV push + 50mL D50	N/A	N/A	Monitor; repeat as required	
Any individual or combination of above, as available	Minimum	See above	N/A	N/A		
Management of Injured Extremity						
Extremity compartment syndrome	Best	Clinical assessment • 6 Ps* • Rigid compartment	---	---	Fasciotomy: only if qualified medical personnel or teleconsultation available	
	Minimum				Cool limb (evaporative or environmental cooling, no ice/snow)	
Tourniquet (for crush management)	Best	If adequate fluids are unavailable, or arrhythmia cannot be managed during entrapment and extrication	If entrapment time >2 hours, consider tourniquet. Place two tourniquets side by side and proximal to the injury	If the patient meets criteria for tourniquet conversion or removal, and fluids are available, initiate crush injury protocol before loosening tourniquet.		
Tourniquet (for irreversible injury)		A limb that is cool, insensate, tensely swollen, and pulseless is likely dead. Patient may develop shock and kidney damage, and may die.				Consider fasciotomy. If no improvement, place two tourniquets side by side and proximal to the injury. Amputation anticipated
Pain						
			Per TCCC	Per TCCC	Per TCCC	Pain/sedation CPG
Infection Control						
Antibiotics	Best	Portable monitor with ECG	Ertapenem, 1g IV/day (1g, 10mL saline or sterile water)			
	Better	Check intermittent vital signs	Cefazolin, 2g IV every 6 to 8 hours; clindamycin (300–450mg by mouth three times daily or 600mg IV every 8 hours); or moxifloxacin (400mg/day; IV or by mouth)			
	Minimum	Monitor pulse and mental status	---	---	Ensure wounds cleaned and dressed, and hygiene of wounds and patient optimized to the extent possible given environment.	

N/A, not applicable; UOP, urine output. *6 Ps: Pain persisting despite adequate analgesia is most important symptom, followed by paresthesia, pallor, paralysis, poikilothermia, pulselessness

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Damage Control Resuscitation

This CPG provides evidence–based guidance to minimize variation in resuscitation practices and improve the care of massively hemorrhaging, severely injured casualties.

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SUMMARY OF UPDATES

RAPID UPDATES

***Aug 2023**: Calcium caution statement added.*

Jun 2023

- *Calcium administration changed to 1 gram calcium.*
- *Tranexamic acid (TXA) 2gm bolus is now favored over the traditional 1gm prehospital bolus followed by 1gm infusion over 8 hours. The 2gm TXA bolus should be given as close to the time of injury as possible and not outside of the 3 hours window.*

Jul 2019

- Greater emphasis on the use of Low Titer O Whole Blood (LTOWB) as the optimal strategy to deliver a balanced and maximally hemostatic resuscitation, with platelet functionality, safely.
- Risk factors for massive transfusion (MT), International Normalized Ratio (INR) threshold updated to > 1.5.
- Earlier calcium use recommended. One gram of calcium IV/IO should be given to patients in hemorrhagic shock during or immediately after transfusion of the first unit of blood product and with ongoing resuscitation after every 4 units of blood products. Ideally, ionized calcium should be monitored and calcium should be given for ionized calcium less than 1.2mmol/L.[1-5]
- Blood pressure goals for DCR have been adjusted to a target systolic blood pressure (SBP) goal of 100 mmHg (110mmHg for traumatic brain injury (TBI)).
- Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) updated as a fielded option for the control of non-compressible torso hemorrhage. REBOA continues to be recommended for designated resuscitation teams and NOT intended to be used by the combat medic or corpsman.
- The use of hydroxyethyl starch (Hextend, Hespan) as a resuscitation fluid is NO LONGER RECOMMENDED and has been removed from the guideline.
- The use of recombinant human activated factor VII (rhFVIIa) is no longer recommended.

Damage Control Resuscitation

HEMORRHAGE is the leading cause of preventable death

DO YOUR PART TO CONTROL IT

RECOGNIZE IT

Injury Pattern

- ✓ Amputations
- ✓ Pelvic injury
- ✓ Penetrating chest/abd

eFAST

- ✓ 2 regions +

Data

- ✓ SBP < 100
- ✓ HR > 100
- ✓ HCT < 32
- ✓ pH < 7.25
- ✓ Lactate > 2.5
- ✓ INR > 1.5
- ✓ Base Deficit >6

STOP IT

- ✓ Tourniquets
- ✓ Hemostatic dressing
- ✓ Direct pressure
- ✓ Junctional tourniquets
- ✓ TXA 2gms
- ✓ Appropriate surgical care ASAP (<1 hr)

REPLACE IT

- NO CRYSTALLOID
- NO HEXTEND
- ✓ LTOWB
- ✓ WFWB
- ✓ Plasma: RBC (1:1:1)
- ✓ Warmed
- ✓ TXA (< 3 hrs)
- ✓ Calcium
  - 1 gm Calcium IV/IO
  - After 1st unit
  - Then every 4th unit

METRICS

- 1st Fluid is Blood
- Whole Blood
  OR
  Plasma:RBC:Plts:Cryo(1:1:1:1)
- TXA given
- Calcium given

Clinical tips based on the Damage Control Resuscitation Clinical Practice Guideline (CPG) published by the Joint Trauma System (JTS).

JTS CPGs : HTTPS://JTS.HEALTH.MIL/INDEX.CFM/PI_CPGS/CPGS

EXECUTIVE SUMMARY

Hemorrhage is the leading cause of preventable death on the battlefield.[6] Of the 4,596 combat deaths reported in COL Brian Eastridge's 2012 review *Death on the Battlefield*, 976 casualties died with injuries that an expert panel classified as potentially survivable, and the vast majority of these deaths—just over 90%—were secondary to uncontrolled hemorrhage. Subsequent interventions focusing on point of injury hemorrhage control and prehospital Tactical Combat Casualty Care were predictably successful, and particularly when paired with rapid evacuation and prehospital blood resuscitation. In fact, data published in studies by Col Stacy Shackelford et al. showed that blood given in the prehospital setting as soon as possible after injury improved both 24 hour and 30-day survival.[7] In short, in the setting of active hemorrhage, the combination of point-of-injury hemorrhage control (per Tactical Combat Casualty Care guidelines), rapid evacuation, and pre-hospital blood resuscitation saves lives.

BACKGROUND

Damage Control Resuscitation (DCR) is generally accepted as a complementary strategy usually paired with Damage Control Surgery (DCS), which focuses surgical interventions to those which address life- threatening injuries and delays all other surgical care until metabolic and physiologic derangements have been treated.[8] Recognizing that this approach saved lives, DCR was developed to work synergistically with DCS and prioritize non-surgical interventions which may reduce morbidity and mortality from trauma and hemorrhage.[9] The major principle of DCR is to restore homeostasis, prevent or mitigate the development of tissue hypoxia, oxygen debt and burden of shock, as well as coagulopathy.[10,11] This amounts to preventing 'blood failure,' specifically with a goal of restoring blood functionality (improving oxygen delivery and tissue perfusion, reducing acidosis, preventing fibrinolysis, reducing coagulopathy, protecting the endothelium, and reducing platelet dysfunction). This is best accomplished through aggressive hemorrhage control and a blood product-based resuscitation, which restores tissue oxygenation, avoids platelet and coagulation factor dilution, and also replaces lost hemostatic potential. DCR is most effective when resuscitation replaces lost blood with whole blood, whether ideally transfused as units of whole blood (WB), or blood product components transfused in a ratio approximating whole blood (i.e. 1:1:1 ratio of FFP:Plt:RBC). Additional goals of DCR are avoidance or limiting of the use of crystalloids to avoid dilutional coagulopathy, selective use of hypotensive resuscitation (SBP of 100 or SBP of 110, if TBI suspected until surgical control is achieved, correction of coagulopathy and acidosis, maintenance of normothermia, empiric administration of Tranexamic Acid in appropriate patient populations, and expeditious evacuation to damage control and definitive surgical capabilities.

Advanced Trauma Life Support (ATLS) guidelines historically advocated a linear resuscitation strategy beginning with an emphasis on crystalloid infusion, particularly during the pre-hospital phase, followed by the addition of red blood cells (RBCs), and finally plasma. Platelets were delayed until a low platelet count was documented and reserved either for severe thrombocytopenia or thrombocytopenia in the presence of active hemorrhage. As documented in retrospective reports from the civilian trauma literature, this approach resulted in excessive crystalloid use and is associated with a risk of dilutional coagulopathy, abdominal compartment syndrome, multiple organ failure, and death[12]. Although selection bias may have contributed to these findings, it should be noted that the ATLS 10th edition identifies that resuscitation with greater than 1.5L of crystalloid is associated with increased mortality and suggests limiting crystalloid use to no more than one liter during the initial resuscitation. Instead, current ATLS recommendations for bleeding patients are for early administration of blood products, including plasma and platelets, while focusing on rapidly achieving hemorrhage control.[13]

During the conflicts in Iraq and Afghanistan between 2003 and 2012 14% of patients admitted to Role 3 military treatment facilities (e.g., combat support hospitals) received a transfusion of at least one blood product. Of these, 35% received MT. (MT is defined as ≥ 10 units of RBCs and/or WB in 24 hours. The proportion of transfused patients receiving MT reached approximately 50% by 2011 in parallel with increasing injury severity scores, use of blood resuscitation, and decreased use of crystalloid and colloid use.[14] During this period mortality fell as military clinicians became experts in the treatment of very severe multisystem trauma accompanied by massive hemorrhage. Civilian ATLS-based practice gave way to a hemostatic resuscitation approach designed to mimic WB functionality.

There is now strong retrospective evidence in both civilian and military trauma populations that patients requiring MT benefit from a higher ratio of plasma and platelets to red cells (e.g., 1 unit plasma: 1 unit platelets: 1 unit RBCs). MT at a 1:1:1 ratio is associated with improved survival.[9, 15-18] Recently, prospective randomized data from the Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) trial revealed that mortality at 3 hours after injury due to exsanguination was lower in patients resuscitated with a 1:1:1 ratio compared to 1:1:2.[13] These were important findings given that the differences between resuscitation strategies were small—and probably best characterized by an early vs. late platelet approach. There was no difference in overall mortality at 24 hours or 30 days, likely due to the confounding effect of head injury. Balanced resuscitation was not associated with increased complication rates.[19,20]

Although physicians continue to debate the lessons of the PROPPR trial and the relative benefits of specific blood component ratios, the practice of giving large amounts of crystalloid or RBCs alone during the initial resuscitation is no longer standard practice. As stated above, in combat casualties with bleeding, EARLY blood product resuscitation (ideally within 36 minutes of injury) provides the lowest early and late mortality rates.[2] Available data on balanced resuscitation comes from component-based resuscitation. We know that any blood product combination represents an advantage over salt-based crystalloids for the bleeding casualty. However, LTOWB represents the best way to deliver a functional resuscitation early, clinically as well as logistically.

BLOOD PRODUCTS FOR DCR

WHOLE BLOOD

Whole blood delivers all the components of blood in the same ratio in which they were lost; WB is independently associated with improved survival.[21-23] In deployed environments, the logistical challenges of maintaining a supply of blood components have led to the use of WB collected onsite from “walking blood banks,” specially to provide platelets for hemostatic resuscitation. Depending on where the blood products have been collected, some of the whole blood products in the deployed setting (platelets or WB) are not prospectively tested for Transfusion-Transmitted Diseases (TTDs). Rapid TTD test kit use is encouraged to screen for HIV, Hepatitis B and C, and malaria or other diseases for which kits are available. Recipients of these blood products must be tested at 3-, 6- and 12-months post- transfusion to monitor for disease transmission.

Type-Specific Whole Blood (TSWB), often referred to as Fresh Whole Blood (FWB), is collected from donors in the deployed setting and must be an ABO match with the recipient. The availability of TSWB may be limited due the constrained pool of donors who must be tested for TTDs and blood group compatibility with recipients. In addition, the chaotic conditions of mass casualty scenarios complicate the matching of blood types between donors and recipients, increasing the risk of clerical errors causing hemolytic transfusion reactions.

In order to improve the availability and safety of WB, low anti-A and anti-B titer (<256 by tube method, though the definition of ‘low titer’ can vary by medical agency or facility) group O blood has been identified

as a practical, effective universal blood product for resuscitation of exsanguinating hemorrhage.[24,25] Like all blood donors, "O low titer" donors should be tested for TTDs and undergo confirmatory typing and an antibody screen (type and screen) in addition to testing for anti-A and anti-B antibodies. LTOWB can be collected from pre-screened walking blood banks in the deployed setting or collected in Armed Services Blood Program donor centers and stored refrigerated for 21 days in CPD or 35 days in CPDA-1.[26] It is important to note that LTOWB has been used safely in the military setting since WW1, with hundreds of thousands of units transfused and only one recorded hemolytic reaction, due to a clerical error.[27]

In 2014 the U.S. Army Rangers developed and instituted the Ranger O Low titer blood (ROLO) program. Low Titer Rangers were identified as a screened donor pool serving as an immediate WBB capability (approximately 2/3 of the group O Ranger population is naturally low titer, generally accepted as having anti-A and anti-B levels less than 1:256 concentration). Every Ranger is trained in how to set up and administer a Fresh Whole Blood buddy transfusion. This program represents a success story of leadership and since 2015 every Ranger task force has deployed with a functional ROLO program. This model is currently being broadened to other prehospital communities.

Available data suggest that Cold-Stored WB (CWB) will provide robust platelet hemostatic function during the first 2 weeks of storage. When using anticoagulants and preservatives such as CPD and CPD-A, function is moderately reduced during the remaining shelf life (21 days for Citrate Phosphate Dextrose (CPD) WB and 35 days for Citrate Phosphate Dextrose Adenine (CPDA-1) WB), but it should be noted that some platelet function remains and that WB plasma hemostatic function is comparable to that of liquid plasma. Throughout its shelf life, CWB remains a relatively hemostatic product compared to RBCs and plasma alone[28-30] Patients receiving MT with CWB stored for more than 2 weeks may require additional support with platelet transfusions or FWB (consider a ratio of 3:1 of CWB: FWB as available). Similarly, CWB that has been leukoreduced with a filter that does not spare platelets and that contains fewer or effectively no platelets require supplementation with platelet or FWB transfusion.[31] Cold-stored LTOWB and TSWB have been used successfully and safely to treat trauma and other causes of massive hemorrhage, such as obstetric emergencies and bleeding in cardiac surgery, in leading U.S. civilian hospitals.[30,32-40]

WB is standard practice for resuscitation of combat casualties. For guidance regarding use of FWB, see the Joint Trauma System (JTS) CPG entitled *Fresh Whole Blood Transfusion*.[41]

RED BLOOD CELLS

RBC units may be stored for up to 42 days under refrigeration when stored in additive solution (e.g., AS-5) or 35 days if stored in CPDA1. In addition, "frozen" RBCs (stored frozen with glycerol cryoprotectant for up to 10 years at <-65°C, then thawed and rinsed in an automated process prior to transfusion) are used interchangeably and successfully with standard RBC units when needed, although these units require at least an hour and a half and specialized equipment to prepare. Transfusion of thawed fRBC units without removal of glycerol is absolutely contraindicated and is lethal to the recipient. Thawed and deglycerolized RBCs can be stored for 14 days with refrigeration. For guidance regarding use of fRBCs see the JTS CPG entitled *Frozen and Deglycerolized Red Blood Cells*.[42]

PLASMA

Plasma can be stored frozen and then thawed on-demand (FFP), or pre-thawed and stored refrigerated for up to 5 days (so-called "thawed plasma"). The delay in treatment imposed by slow thawing of FFP (up to 30 minutes or more) has necessitated the widespread maintenance of thawed plasma inventories for immediate, emergency use. This typically results in significant waste due to the 5-day post-thaw shelf life. Plasma can also be supplied as "liquid" (never frozen) plasma and stored for 26 days in CPD anticoagulant

solution, or 40 days in CPDA-1. Available data suggest that "thawed" and "liquid" plasma may be functionally interchangeable in most trauma patients. Note that no randomized trials have compared these products and the data regarding the hemostatic capacity of liquid plasma stored beyond 28 days are very limited.[42,43] Although group AB plasma is classically considered the universal donor, it is now widely recognized that A plasma can, in fact, be considered universal since group A individuals do not generally make high titer anti-B antibodies and B red cells express the B antigen at low density, thus making them much less susceptible to hemolysis than A red cells.

Freeze-Dried Plasma (FDP) was used by U.S. Forces during World War II and has been in use by the French military since the 1940s. French military FDP is available to U.S. Special Operations Forces under an Emergency Use Authorization from the Food and Drug Administration (FDA).[24] FDP is considered functionally interchangeable with other plasma products for trauma resuscitation. FDP or Spray-Dried Plasma (SDP) may become more broadly available to U.S. Forces in the near future.[44-45]

PLATELETS

In contrast to red cells and plasma, platelets collected in theater by apheresis traditionally have been stored at room temperature (20-24°C), under constant agitation, for a maximum of 5 days with an extension to 7 days total if shipped to another facility. These storage conditions are optimized to extend in vivo platelet circulation, but not hemostatic function, safety, or availability.[46] Platelets are vital for hemostasis and their early use in a balanced transfusion strategy is associated with increased survival in trauma.[16,19,47,48] Platelets stored under refrigeration (1-6°C), or "Cold-Stored Platelets" (CSP), maintained without agitation for up to 3 days in plasma, have long been approved by the FDA for treatment of bleeding patients. Refrigerated storage better preserves platelet hemostatic function and clearly reduces the risk of bacterial growth, the major hazard of transfusing room temperature-stored platelets.[49,50] CSP have been proven effective in clinical trials and used successfully in combat trauma patients in the U.S. Central Command area of operations.[53] Cold-stored platelets in platelet additive solution (CSP-PAS) or plasma retain function for at least 15 days and are compatible with blood warmers and rapid infusers.[51] CSP can be collected in theater and used interchangeably with other platelet products.[52]

Fibrinogen concentrate has not been studied adequately in trauma patients either, but several factors suggest that it may be helpful. These include: 1) fibrinogen is the fundamental substrate of clot formation; 2) fibrinogen is rapidly consumed in trauma; and 3) cryoprecipitate, a less purified source of fibrinogen, has been shown to be an essential component of MT protocols for mitigating the dilutional coagulopathy caused by red cell additive solution and anticoagulant.[17,53-56]

Prothrombin Complex Concentrates (PCCs) are only indicated for patients requiring urgent warfarin reversal and have not been adequately studied in a broad trauma population. PCCs could be considered if: 1) the patient is anticoagulated; or 2) there is clear evidence of delayed initiation of clot formation refractory to platelets, fibrinogen, or cryoprecipitate and TXA (e.g., prolonged thrombelastography rapid time [TEG-R] or rotational thromboelastometry clotting time [ROTEM CT]). PCCs should not be routinely used in trauma outside the context of a clinical trial as they may cause harm due to excessive thrombogenicity.[57]

HEMOSTATIC ADJUNCTS FOR DCR

MECHANICAL HEMORRHAGE CONTROL

In addition to blood replacement, DCR strategies also focus on limiting blood loss with hemorrhage control devices and adjunctive pharmaceutical therapies. Availability and usefulness ofinterventions are determined by the type of injury and location of bleeding. Effective tourniquets (e.g., Combat Application

Tourniquet, Special Operations Forces Tactical Tourniquet) have been developed for extremity injury and may be responsible for saving more wounded service members in Iraq and Afghanistan than any other single medical intervention. Junctional (axillary, neck, and groin) hemorrhage, previously a nearly intractable problem, can now be treated with approved junctional tourniquets (e.g., Combat Ready Clamp, SAM® Junctional Tourniquet, Junctional Emergency Treatment Tool) and the XSTAT™ device, which injects absorbent sponges into deep wounds to tamponade bleeding.[58-60] Superficial wounds are amenable to novel and effective hemostatic dressings (e.g., Combat Gauze or Celox/Celox Rapid gauze).

Truncal internal hemorrhage is non-compressible and is the subject of intensive research. Resuscitative Endovascular Occlusion of the Aorta (REBOA) has emerged as a technique for truncal hemorrhage control. The newest device available does not require fluoroscopic guidance and has become widely available; in expert hands on teams with appropriate training, REBOA may improve survival from non- compressible truncal hemorrhage. There is no 24-hour outcome data on the use of REBOA in the combat environment. Teams that use this technique should be submitting clinical data to the JTS in order to better understand this capability and how it effects outcomes from hemorrhage. The ideal application of REBOA in the combat environment is evolving, but the technique, when used appropriately, has the potential to significantly improve outcomes from non-compressible truncal hemorrhage. Currently, REBOA use is supported for austere surgical teams, and teams that have an immediate surgical capability are using REBOA. See the JTS *REBOA for Hemorrhagic Shock* CPG. [61-67]

PHARMACOLOGIC ADJUNCTS

Hemostatic pharmaceutical adjuncts to limit blood loss are another subject of considerable investigation.

Tranexamic acid (TXA) is the only therapy in this class that has been found to reduce mortality in a large Randomized Controlled Trial (RCT). Strong evidence demonstrates a significant improvement in survival following the early use of TXA, but only when given within 3 hours of injury.[68,69] Significant trauma-- in particular, penetrating trauma with hemorrhage--has been associated with coagulopathy, in part secondary to the activation of fibrinolysis.[1,70] Such hyperfibrinolysis occurs in the most severely injured patients (approximately 4% of trauma patients in major civilian U.S. trauma centers) and portends poor outcomes.[9,71] Anti-fibrinolytic agents, including TXA, have been used to decrease bleeding and to reduce the need for blood transfusions in coronary artery bypass grafting, orthotopic liver transplantation, hip and knee arthroplasty, obstetrics, and other surgical settings. The safety and efficacy of using TXA to treat trauma patients was evaluated in a large randomized, placebo-controlled clinical trial *The Clinical Randomization of an Antifibrinolytic in Significant Hemorrhage (CRASH-2).*[72] In this trial, 20,211 adult trauma patients in 274 hospitals in 40 countries with, or at risk of, significant bleeding (HR>110, SBP<90, clinical judgment) were randomized to either TXA or placebo. The authors reported that TXA use resulted in a statistically significant reduction in the relative risk of all-cause mortality of 9% (14.5% vs.

%, RR 0.91, CI 0.85-0.97; p = 0.0035). It was in this group of most severely injured patients thatuse of TXA was associated with the greatest reduction in risk of death.

A registry-based study of combat-injured troops receiving blood in Afghanistan (January 2009 - December 2010) demonstrated a decreased mortality with TXA use in this population. The TXA group was more severely injured (ISS: 25.2±16.6 vs. 22.5±18.5; p<0.001), required more blood (11.8±12.1 vs. 9.8±13.1 pRBC units; p<0.001), had a lower Glasgow Coma Score (7.3±5.5 vs. 10.5±5.5; p<0.001) and initial systolic blood pressure (112±29.1 vs. 122.5±30.3 mmHg), but also had a lower unadjusted mortality than the no-TXA group (17.4% vs. 23.9%; p=0.028). In the massive transfusion cohort (N=321; 24-hour transfusion: 21.9±14.7 pRBC; 19.1±13.3 FFP and 3.5±3.2 apheresis platelet units), mortality was also lower in the TXA group compared to the no-TXA group (14.4% vs. 28.1%; p=0.004). In a multivariate regression model, TXA use in the massive transfusion cohort was independently associated with survival (odds ratio: 7.28; 95% confidence interval:

3.02-17.32). A subsequent larger retrospective analysis of TXA use outcomes in military casualties documented an increased rate of venous thromboembolism in patients receiving TXA.[73] Estimates of TXA effects on mortality suggested that an adequately powered study would likely observe an effect size in line with CRASH-2 findings.

This survival benefit associated with TXA supports its use in conjunction with damage control resuscitation following combat injury. This association is most prominent in those requiring massive transfusion.[14,74] In casualties at high risk of hemorrhagic shock, ***TXA reduces mortality IF GIVEN WITHIN THREE (3) HOURS of injury***, optimal use of TXA requires that it be given as soon as possible when indicated rather than suggesting that TXA administration any time within 3 hours after injury is acceptable.[75,76] TXA given empirically greater than 3 hours post-injury increases the risk of mortality. For eligible casualties, 2 grams of TXA should be administered IV or IO. (See next section *Recognition of Patients Requiring DCR* to determine eligible casualties.) TXA is ideally administered in 100 ml of normal saline over 10 minutes, but faster administration in more concentrated form can be considered. Administration of undiluted TXA by slow IV push (given over 10 minutes) is acceptable if supplies or tactical situation prevents 100mL IV infusion.[77] It should be noted that rapid infusion of TXA has been infrequently associated with transient hypotension. Although Lactated Ringer's (LR) solution is compatible with TXA, its use should be avoided in this setting since the mixing of calcium containing LR with blood products in chaotic resuscitation settings may cause clotting of blood products and thromboembolic phenomena. Normal saline and PlasmaLyte A are the only crystalloid solutions compatible with blood products.

CAUTION: Do not mix medications and blood products in the same IV line. Use a separate line or flush well between giving medications and blood products.

Hypocalcemia is a problem in most actively bleeding trauma patients on presentation, and administration of even one unit of citrated blood product can further lower ionized calcium to levels approaching critical values (<0.9mmol/l). One gram of calcium IV/IO should be given to patients in hemorrhagic shock during or immediately after transfusion of the first unit of blood product and with ongoing resuscitation after every 4 units of blood products. At a minimum, one gram of calcium should be administered after no more than 4 units of blood product have been infused to avoid citrate toxicity. Ideally, ionized calcium should be monitored and calcium should be given for ionized calcium less than 1.2mmol/L. This should be done at the first level of care capable of monitoring these patients, typically a Role 2 equivalent or above. Appropriate calcium solutions should otherwise be administered per protocol for signs and symptoms of hypocalcemia (e.g., prolonged QTc, ventricular arrhythmias, decreased cardiac output/cardiovascular collapse, coagulopathy, tetany, laryngospasm, seizures, and paresthesia).

CAUTION: Calcium gluconate is safer for peripheral use. Calcium chloride may cause severe skin necrosis if extravasation occurs through a partially dislodged IV or IO catheter. The risk of bone necrosis with IO injection of calcium chloride is not known. When using peripheral IV or IO access, use extreme caution to ensure the device is in good intravascular position and no extravasation occurs.

Note that hypomagnesemia is also common in trauma patients and is worsened by citrate- containing blood products. Hypomagnesemia may contribute to increased cardiac irritability and risk of fatal arrhythmias. Consideration should be given to replacing magnesium in the setting of severe hypocalcemia and massive transfusion.[4,78-80]

The use of rFVIIa is no longer recommended in most trauma patients since it has not been shown to reduce mortality and may increase risk of adverse events.[81-85]

MANAGEMENT PRINCIPLES FOR DCR

RECOGNITION OF PATIENTS REQUIRING DCR

Patients receiving uncross matched Type O blood in the Emergency Department (ED) or resuscitation area and later receiving cumulative transfusions of 10 or more RBC units in the initial 24 hours post- injury (MT) are widely recognized as being at increased risk of morbidity and mortality due to exsanguination. Ideally, these patients should be rapidly identified and hemostasis established at the earliest level of care possible in order to prevent or mitigate shock and coagulopathy. Due to diagnostic challenges, particularly in the case of truncal hemorrhage, anticipating the transfusion needs of these patients requires experience and the coordination of extensive resources, including development of MT protocols.

Robust pre-hospital data are lacking, but a number of factors predict the need for MT support in trauma.[86] In a patient with serious injuries, the presence of 3 of the 4 features below indicates a 70% predicted risk of MT and 85% risk if all 4 are present:

- Systolic blood pressure < 100 mm Hg
- Heart rate > 100 bpm
- Hematocrit < 32%
- pH < 7.25

Other risk factors associated with MT or at least need for aggressive resuscitation.[86-90]

- Injury pattern (above-the-knee traumatic leg amputation especially if pelvic injury is present, multi-amputation, clinically obvious penetrating injury to chest or abdomen)
- >2 regions positive on FAST scan
- Lactate concentration on admission >2.5
- Admission INR ≥ 1.5
- BD > 6 mEq/L

Recognition of clinical patterns associated with the need for MT is essential for effective triage. These include uncontrolled truncal or junctional bleeding, uncontrolled major bleeding secondary to large soft tissue injuries, proximal, bilateral, or multiple amputations, a mangled extremity, clinical signs of coagulopathy (e.g., paucity of clots or petechial bleeding), or severe hypothermia. It is critical to communicate with the blood bank at the medical treatment facility when a potential MT patient has been identified. Blood banks within theater have developed procedures for providing blood products in the appropriate proportion to support resuscitative efforts. Upon arrival to the ED, laboratory evaluation such as viscoelastic testing (TEG or ROTEM) may also facilitate early identification of patients who will require MT, although this technology is not widely available in the deployed setting, particularly at Role 2 facilities.[91,92] It should be noted that many point-of-care coagulation tests that measure Prothrombin Time/International Normalized Ratio (PT/INR) have linear ranges only between INR 2.0-3.0 and are unreliable in clinical conditions characterized by loss of fibrinogen. These devices should not be relied upon to evaluate the coagulation function in trauma patients.[93,94]

POINT OF INJURY, EN-ROUTE, & REMOTE DCR

For detailed recommendations on prolonged field care (PFC) damage control resuscitation, see the *JTS Damage Control Resuscitation for PFC CPG, 01 Oct 2018*.

OPTIMIZATION OF FLUIDS

Volume resuscitation, particularly crystalloid and colloid, should be used sparingly in the pre-hospital setting, given the potential for harm and the limited resources; blood products are preferred for hemorrhagic shock resuscitation.[9,95] WB (Group O low titer preferred) or blood components given ideally at a 1:1:1 (plasma, platelets, RBC) ratio should be transfused when shock is present or expected. Blood products should ideally be warmed with approved in-line blood heaters with the goal of transfusing products warmed to 37°C.

Casualties at low risk of developing shock should NOT receive IV fluids or adjunctive medications.

Hypertonic Saline does NOT improve mortality in hemorrhagic shock and should only be used for patients with TBI and evidence/suspicion of raised Intracranial Pressure (ICP).[96,97] Vasopressors are NOT recommended for the treatment of hemorrhagic shock.

A key element of fluid optimization is careful documentation of all fluids, interventions, and medications given in the pre-hospital phase.

ADJUNCTIVE THERAPIES IN PFC

Compressive / hemostatic dressings and devices

Prevent further hemorrhage with direct pressure, topical hemostatic dressings, and/or tourniquets, if possible, to minimize the risk of shock. REBOA can be highly effective if rapidly implemented by skilled and designated teams.

Prevention of acidosis and hypothermia

Metabolic acidosis resulting from acute trauma is a consequence of inadequate tissue perfusion leading to lactic acid production and is best addressed with resuscitation with WB or equal ratio components. Crystalloid resuscitation will contribute to the acidosis and should be avoided. Hypothermia is multifactorial and strategies should address as many causes as are identified, including cold exposure, cold resuscitation fluids, significant blood loss, and shock. Hypoperfusion contributes to development of hypothermia due to decreased heat production. Prior to arrival at the military treatment facility, heated fluids, fluid blankets, and ventilators may not be available, but wounds should be covered, “space blankets” (e.g., HPMK) used to cover the casualty, and shock avoided or treated. See JTS Hypothermia Prevention CPG for additional information.[98] In patients with isolated extremity injuries treated with tourniquets, the extremity distal to the tourniquet should be left exposed and cooled relative to the patient’s core in order to increase the likelihood of preserving the ischemic limb’s viability.[99]

Expeditious delivery to definitive surgical control

Casualties may require care as described and emergency procedures for life-threatening conditions in the pre-hospital setting; however, these should be balanced against the need to expeditiously deliver the patient to definitive care. DCS at Role 2 forward surgical units should focus only on control of hemorrhage and prevention of ongoing contamination. Only absolutely necessary procedures should be performed. In

general, every effort should be made to deliver the critically injured casualty to the highest available level of care as rapidly as possible.

DCR AT MEDICAL TREATMENT FACILITIES

Although principles remain the same, DCR in medical facilities differs in that there are more resources available, including access to operative surgical control. Also, some therapies such as TXA may have already been given in the pre-hospital phase. Resuscitation to physiologic endpoints such as lactate and base deficit should be considered since tissue hypoxia and oxygen debt are known drivers of coagulopathy. Reversal of tissue hypoxia should thus be a central tenet of hospital-based resuscitation. Specifically:

OPTIMIZATION OF FLUIDS

Volume resuscitation with crystalloids should NOT be first line of care in MTFs due to the potential for harm. Crystalloid fluids should be reserved for specific clinical uses, such as carrier fluid for intravenous medication or other non-resuscitative uses. The order of priority for fluid administration should be:

- Fully TTD tested (performed in FDA registered testing facility/FDA approved) whole blood
- Blood components at a 1:1:1:1 ratio (plasma:platelets:RBC:CRYO)
  Note that apheresis platelets may be collected in theater and therefore are not FDA approved and fully tested prior to transfusion.
- Whole blood from a recently tested donor *(**NOTE:** this option is only acceptable in the hospital for emergency indications when full component therapy is not available)*
- RBCs plus plasma=1:1 ratio
- Plasma with or without RBCs
- RBCs alone

BLOOD PRODUCT TRANSFUSION

Cryoprecipitate is available in hospital settings and should be added to the component mix to create a 1:1:1:1 ratio of products in order to adequately supply fibrinogen and other clotting factors (Factors VIII, XIII, and vWF).

When operationally necessary due to component shortages, WB from walking blood banks can be life-saving. For additional information, refer to the *JTS Whole Blood Transfusion CPG*.[41]

Continual reassessment of the casualty status is needed during and between transfusions. As the patient stabilizes, component ratios should be replaced by 'goal-directed' therapy guided by laboratory evaluation, including CBC, blood gases, calcium levels, PT/INR, Activated Partial Thromboplastin Time (aPTT), and viscoelastic testing (ROTEM® or TEG) if available.

ADJUNCTIVE THERAPIES AT MTF'S

Hypotensive resuscitation

As in the pre-hospital period, resuscitation of casualties without CNS injury prior to definitive surgical control should maintain a lower target SBP (100 mmHg, range 90-110mmHg) to reduce hemorrhage by minimizing intravascular hydrostatic pressure. Hypotensive resuscitation should not be utilized for patients with

isolated CNS injury because of associated adverse outcomes in this population (goal SBP >110mmHg). For additional information, see the *JTS Neurosurgery and Severe Head Injury CPG*.[97]

Compressive / hemostatic dressings and devices

Until definitive surgical control is established, prevent further hemorrhage with direct pressure, topical or truncal hemostatic dressings, and/or tourniquets or REBOA to avoid the development of shock. In extremis, procedures such as resuscitative thoracotomy are indicated. Use of these devices should occur as rapidly as hemorrhage is identified and should not unnecessarily delay transport to the operating room.

Prevention or correction of hyperfibrinolysis

TXA should be given to casualties at risk of hemorrhagic shock who have not already received a dose during the pre-hospital phase. THE CASUALTY SHOULD ONLY RECEIVE INITIAL TXA IF ADMINISTERED WITHIN THREE (3) HOURS OF INJURY. When given > 3 hours post-injury, TXA increases the risk of mortality. The mortality data were not analyzed in patients with hyperfibrinolysis documented by viscoelastic testing (ROTEM® or TEG). However, documented hyperfibrinolysis in the setting of ongoing hemorrhage should be treated according to clinical judgment. For eligible casualties (see section above titled Recognition of Patients Requiring DCR), 2 grams of TXA should be administered IV or IO. TXA is ideally administered in 100 ml of normal saline over 10 minutes, but faster administration in more concentrated form can be considered. It should be noted that rapid infusion of TXA has been infrequently associated with transient hypotension.

Prevention of acidosis and hypothermia

Hypothermia is multifactorial and strategies should address as many causes as are identified, including cold exposure, cold resuscitation fluids, significant blood loss, and shock. Hypothermia occurs even when ambient temperatures are elevated and medical personnel are uncomfortably warm, due to blood loss and hypoperfusion. Treatment should include urgent, active re-warming with all available means including heated fluids, heated blankets, ventilators, warm environments, and rapid surgical care to minimize blood and heat loss.

Expeditious delivery to definitive surgical control

As with casualties in the pre-hospital setting, pre-surgical care should be balanced against the need to expeditiously deliver the patient to the operating room.

CONCLUSION

The DCR approach to the initial management of a critically injured casualty requires a significant expenditure of resources and the coordination of a diverse group of health care providers. This is frequently performed in a clinical scenario of multiple casualties and limited resources. It is incumbent upon the clinical leaders at each level of care to be fully versed on available resources and to employ them judiciously and appropriately. Patients requiring MT should be resuscitated using DCR principles and should undergo early DCS.

PERFORMANCE IMPROVEMENT MONITORING

POPULATION OF INTEREST

1. All patients who receive blood product transfusion within 3 hours of injury

2. All patients with severe traumatic injury (ISS ≥16 and ≥ 2 body regions injured with AIS severity ≥ 2 AND SBP < 100 OR HR > 100 OR hematocrit < 32% OR pH <7.25 within 3 hours of injury)
3. Massive transfusion includes all patients who received 10 or more units of RBC + WB within first 24 hours.

INTENT (EXPECTED OUTCOMES)

1. All patients in the population of interest receive TXA within 3 hours after injury.
2. All patients in the population of interest who receive 1 or more units of blood product also receive calcium.
3. All MT patients receive transfusion of plasma:RBC in a ratio between 0.5:1 to 1:1.5.
4. All MT patients receive platelet or WB transfusion.
5. All MT patients receive cryoprecipitate or WB.
6. For the population of interest, the first resuscitation fluid given after injury is a blood product, ideally cold-stored LTOWB.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who receive TXA within 3 hours after injury (or documented ROTEM indicating no fibrinolysis).
2. Number and percentage of patients in the population of interest receiving 1 or more units of blood product who also receive calcium.
3. Number and percentage of MT patients who receive plasma:RBC in a ratio between 0.5:1 to 1:1.5. (calculate ratio for first 24 hours).
4. Number and percentage of MT patients who receive platelet or WB transfusion.
5. Number and percentage of MT patients who receive cryoprecipitate or WB.
6. Number and percentage of patients in population of interest who received a blood product as the first resuscitation fluid.
7. Number and percentage of patients in population of interest who received cold-stored LTOWB as the first resuscitation fluid.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- Theater Medical Data Store

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: EXAMPLE OF A MASSIVE TRANSFUSION PROCEDURE AT USCENTCOM LEVEL III FACILITY

CONSIDERATIONS FOR USE WITH MASSIVE TRANSFUSION (MT)

- A flexible procedure for use in the Emergency Department (ED), Operating Room (OR) and Intensive Care Unit (ICU) which can be initiated or ceased by the site-specific provider as dictated by the patient's needs when in that specific venue. It consists of batches as defined below, which vary in composition, but are directed toward approximating a 1:1:1:1 ratio of FFP, platelets, RBC, and cryoprecipitate (CRYO). Note: one unit of apheresis platelets is approximately the equivalent of 6 units random donor platelets, therefore 1u apheresis platelets should be given for every 6 units of RBC to approximate 1:1:1 resuscitation. Crystalloid infusion should be minimized and limited to use as carrier fluid. Hextend® should not be used.
- Note that the MT protocol described below is designed for use with blood components and is designed to provide the functionality of WB. If using WB for MT, the considerations that can be applied from the protocol below include early use of TXA and calcium. Also, if using primarily CWB that has been stored for more than 2 weeks, consider supplementing with additional platelets, either from FWB (consider a ratio of 3:1 of CWB: FWB as available) or from apheresis platelets (consider adding 1 unit of platelets after every 6-10 CWB units if clinically indicated).

Initiate MT procedure if patient has received 4u RBC/4u FFP emergency release blood products.

- Pack One: 6u RBC, 6u FFP, 1u apheresis platelets, 1-2 5-unit bags of cryo. Give TXA empirically if within 3 hours of injury: Infuse 2 grams of TXA in 100 ml of 0.9% NS over 10 minutes intravenously in a separate IV line from any containing blood and blood products. (A more concentrated or rapid injection can be considered but rapid TXA infusion has been infrequently reported to cause transient hypotension.) Give one gram calcium during or immediately after first blood product administered and another gram after every four units of blood product.
- Pack Two: 6u RBC, 6u FFP, 1u apheresis platelets, 1-2 5-unit bags of cryo. Continue to monitor ionized calcium or give 1gm calcium after every 4 blood products.
- Pack Three and beyond: identical to Pack Two

Definitions

Emergency Release: Uncross matched 4u RBC (generally O+ but may be O- for females under the age of 50 if available) and 4u AB or A plasma (NOTE: A plasma is not "universal" but risk of hemolysis in B or AB patients is very low and its use in massive transfusion patients when supplies of AB FFP are limited or absent may improve survival and help preserve resources. A plasma is commonly used as emergency release plasma throughout the United States.)

APPENDIX B: PEDIATRIC CONSIDERATIONS

There are no prospective studies of transfusion resuscitation in pediatric trauma. Most major children's centers extrapolate from adult literature and are using similar damage control resuscitation strategies in major hemorrhage. There are currently no data determining which patients may benefit from these strategies. See Appendix A for a suggested MT Protocol.

For children under a weight of 30 Kilograms (KG), transfusions of RBC units, FFP, or apheresis platelets should be given in "units" of 10-15 ml/kg. One unit of cryoprecipitate is typically administered for every 10 kg of body weight. Blood volume in children can be estimated at between 60-80ml/kg. Bear in mind that a "trauma pack" containing 6 U RBCs + 6 U FFP + 1 U apheresis platelets will deliver between 3000- 4000ml of intravascular volume. A child of 30kg may have a TOTAL blood volume of 1800-2400ml. Over- resuscitation contributes to morbidity and mortality. It may be more convenient and safer to resuscitate children with WB since this product delivers full oxygen delivery and hemostatic functionality and may support more accurate volume dosing. For example, a typical unit of whole blood contains about 500- 600ml (depending on bag type and volume: 450 or 500ml blood volume plus anticoagulant). For a severely injured, shocked child, a quarter to a half of a WB unit may provide adequate initial resuscitation, which can then be further titrated.

Pediatric approved Intraosseous (IO) devices can be used for transfusion if required. Note that sternal IOs designed for adults may pierce a child's sternum and deliver fluids or blood products into the mediastinum.

A MT in pediatrics has been defined as ≥40ml/kg of blood products in 24 hours.[1] The circulating blood volume in children is approximately 60-80 ml/kg. Children are at high risk of developing hypocalcemia, hypomagnesemia, metabolic acidosis, hypoglycemia, hypothermia, and hyperkalemia during MTs.

Therefore, frequent monitoring and correction of acid/base status, electrolytes, and core temperature is essential during the resuscitation of pediatric casualties. An approved blood warmer and other transdermal temperature management system devices are recommended for the prevention and treatment of hypothermia.

Although there are limited retrospective data demonstrating the benefit of TXA in pediatric trauma,[2] there are studies of TXA use in pediatric cardiac, orthopedic, and cranial surgeries showing overall safety and decreased transfusion requirements.[3-6] There is no prospectively validated dosing available for pediatric trauma but loading doses of 10-100 mg/kg IV followed by 5-10 mg/kg/hour infusion doses are commonly used in elective surgery. The UK Royal College of Pediatrics and Child Health has recommended a loading dose of 15mg/kg (up to 1 gm) followed by 2mg/kg/hr over 8 hours (or up to 1gm over 8 hours). This regimen reflects standard adult dosing in trauma.[7]

Viscoelastic clot testing (e.g., TEG or ROTEM®) can be utilized to direct transfusion requirements as in adults utilizing the same thresholds discussed in this CPG.[8] Viscoelastic testing should not be used to withhold TXA during initial resuscitation of bleeding trauma patients.[9]

Prolonged CPR > 20-30 min is generally futile in children who have cardiac arrest with trauma related injuries. Children with traumatic injuries with in-hospital cardiac arrest have a very high mortality after 20-30 min of cardiac arrest.[10]

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APPENDIX C: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command-required, unapproved uses. Some command-requested, unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard practice." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Damage Control Resuscitation (DCR) in Prolonged Field Care (PFC)

The purpose of this guideline is to improve implementation of DCR in the Role 1 PFC environment.

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RAPID UPDATES

01 Sep 2023*: SAVeO2 oxygen parameters*

Jun 2023

- *Calcium administration changed to 1 gram calcium*
- *Tranexamic acid (TXA) 2gm bolus is now favored over the traditional 1gm prehospital bolus followed by 1gm infusion over 8 hours. The 2gm TXA bolus should be given as close to the time of injury as possible and not outside of the 3 hours window.*

INTRODUCTION

Early recognition and intervention for life-threatening hemorrhage are essential for survival. The immediate priorities are to control life-threatening hemorrhage and maintain vital organ perfusion with rapid blood transfusion.[1]

Experience with fresh whole blood (FWB) resuscitation by military surgical teams deployed in US Central Command [2–4] led to a revolutionary change in resuscitation practices, termed damage control resuscitation (DCR).[5] As DCR became the accepted standard in military and civilian trauma practice, the realization that the majority of potentially preventable battlefield deaths occurred prehospital and were attributed to hemorrhage[6] launched a campaign to bring advanced resuscitation capabilities closer to the point of injury.[7,8]

Efforts to prevent death from hemorrhage begin with external hemorrhage control, followed by transfusion of whole blood (WB) or reconstituted WB with components in a 1:1:1 unit ratio when possible.[9] DCR also limits the use of crystalloids to avoid dilutional coagulopathy and incorporates other adjunctive measures to mitigate hemorrhagic shock and acute traumatic coagulopathy, including:

- Early use of tranexamic acid (TXA)[10]
- Calcium repletion in patients at risk of hypocalcemia
- Prevention of acidosis and hypothermia
- Expeditious delivery to a damage control surgical capability

The purpose of this prolonged field care (PFC) guideline is to improve implementation of DCR in the Role 1 [11] PFC environment by augmenting and consolidating the Tactical Combat Casualty Care (TCCC) and Joint Trauma System (JTS) guidelines for PFC situations. When patient evacuation is delayed or not available, evidence-based solutions may not be possible. In such cases, experience-based solutions may provide the best option in a compromised setting with limited resources. The CPG recommendations are presented in a "minimum, better, best" format that presents a hierarchy of approaches to address a spectrum of Role 1 situations and available resources. In all cases, this hierarchy builds on itself with “minimum” clinical standards still applicable in scenarios with the “best” available resources.

DCR principles practiced in the presurgical phase of resuscitation have been termed remote damage control resuscitation (RDCR).[12] It is important to distinguish between RDCR and DCR, because capabilities are different in prehospital versus hospital settings.

RECOGNIZING PATIENTS WHO NEED (R)DCR

GOAL

Recognize patients with traumatic hemorrhage who will benefit from implementing DCR early to decrease mortality.

INITIAL SURVEY

Recognize hemorrhagic shock based on rapid examination and recognition of severe injury pattern.

- Injury pattern consistent with massive hemorrhage:
  - Above-the-knee traumatic amputation, especially if associated with pelvic injury

  - Proximal, bilateral, or multiple amputations (including mangled extremity)
  - Clinically obvious penetrating injury to chest or abdomen
  - Uncontrolled truncal or junctional bleeding
  - Uncontrolled major bleeding secondary to large soft-tissue injuries
- Severe trauma with altered mental status (in the absence of brain injury) and/or weak or absent radial pulse.[9]

If initial survey does not indicate severe blood loss, continue assessment, check vital signs, and assess for signs of shock. Recognize hemorrhagic shock on the basis of presence of severe traumatic injury associated with the following:

- Systolic blood pressure (SBP) less than 100mmHg
- Pulse greater than 100 bpm
- Clinical signs of shock, such as cool extremities, delayed capillary refill
- Clinical signs of coagulopathy (e.g., thin, nonclotting bleeding from multiple sites, bleeding from minor wounds such as intravenous [IV] or intraosseous [IO] sites)

ADVANCED CAPABILITIES

When additional laboratory capability and/or ultrasound are available, confirm evidence of hemorrhagic shock using laboratory and/or imaging studies. Do not delay initiating DCR if hemorrhagic shock is clinically suspected: Begin treating immediately once hemorrhagic shock is suspected.

Predictors associated with massive transfusion (i.e. more than 10 units of blood in the first 24 hours) may help identify patients who will require massive transfusion. The more predictors present, the higher the risk of massive transfusion.[13–22]

- Penetrating mechanism
- Positive focused assessment with sonography for trauma (FAST) examination (especially if two or more regions are positive)
- Lactate concentration greater than 4mmol/L on presentation
- Base deficit more than 6mEq/L (base excess less than −6mEq/L)
- pH less than 7.25
- International normalized ratio (INR) 1.5 or greater

HEMORRHAGE CONTROL

GOAL

Stop external hemorrhage and reduce internal hemorrhage to the greatest extent possible. The first step in DCR is limiting blood loss by early and effective hemorrhage control. Interventions to control external hemorrhage are well described in the TCCC guidelines and should be applied as indicated.

- CoTCCC recommended limb tourniquets
- Wound packing

- Pressure dressings
- Hemostatic dressings (Combat Gauze, Celox Gauze, Chito Gauze, and XStat
- Junctional tourniquets
- Pelvic binders

TOURNIQUET NOTES[9]

- Tourniquets (limb and junctional) should be transitioned to pressure dressings within 2 hours when criteria for conversion are met (i.e. the casualty is not in shock, it is possible to monitor the wound closely for bleeding, and the tourniquets are not being used to control bleeding from an amputated extremity). Tourniquets that have been in place longer than 6 hours should not be removed unless close monitoring and laboratory capability are available.

If the tactical situation or injury pattern does not allow for transition of a tourniquet to a pressure dressing, recognize that the priority is life over limb. At times, the decision to leave a tourniquet in place and commit the patient to an amputation is difficult. Consider telemedicine consultation.

- If a tourniquet has been applied for longer than 2 hours and the decision is made to reduce the tourniquet, resuscitation should address hyperkalemia and reperfusion syndrome, similar to crush injuries. See PFC Clinical Practice Guideline (CPG) Crush Syndrome under Prolonged Field Care.[23]

WOUND PACKING NOTES

- If bleeding continues through the hemostatic dressing, reassess the wound. If the wound is fully packed and additional hemostatic dressings are available, consider removing the first dressing and packing a second dressing. If additional space exists in the wound cavity, augment the first dressing with a second hemostatic dressing or gauze dressing.
- The effectiveness of wound packing may be improved when skin closure over the packing can be achieved, either with suture, skin staples, iTClamp®, or application of a chest seal.

EMERGING TECHNOLOGIES

Emerging technologies that may be considered for internal hemorrhage control.

- **Abdominal Aortic and Junctional Tourniquet (AAJT):**
  - This device, although not well studied, is the only noninvasive device available for aortic occlusion. Application of the AAJT (Compression Works; http:// compressionworks.com) may be considered for occlusion of the distal aorta when the injury pattern suggests bleeding in the pelvis and/or junctional lower extremities.
  - If there is bleeding above the level of the umbilicus, in the upper abdomen or chest, application of the AAJT may increase bleeding.
  - Ideally, ultrasound of the abdomen and chest should be performed to look for bleeding before AAJT application.
  - Per manufacturer's guidelines, the AAJT should not be applied in the abdominal position for more than about 30 minutes.

- In the absence of evidence-based protocol, providers may consider: after 15–30 minutes of active resuscitation with blood products and attention to external hemorrhage control, the AAJT should be slowly released.
- If the systolic blood pressure drops below 90mmHg, reinflate the balloon and transfuse an additional unit of blood before releasing the balloon again. Look for other causes of hemodynamic instability.
- Continue to repeat as resources allow until blood pressure stabilizes or arrival at surgical capability.

- **Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA):** Only an advanced resuscitation team with the capabilities for massive transfusion, ultrasound, and arterial access would be expected to obtain the capability for REBOA placement. This device may be considered for occlusion of the aorta at either the position of the diaphragm (zone I, for abdominal hemorrhage or traumatic arrest) or the distal aorta above the aortic bifurcation (zone III, for pelvic and/or junctional lower extremity hemorrhage). Balloon time should be limited to 30 minutes for zone I. Maximum zone III inflation time is not known, but is likely in the range of 2–3 hours. See Joint Trauma System REBOA CPG.[24] Aggressive blood product resuscitation and balloon deflation protocol must be followed, even without surgical intervention.

RESUSCITATION

GOAL

Optimize fluid resuscitation to treat and reverse hemorrhagic shock effectively. Fluid resuscitation principles in PFC are the same as TCCC. Blood products are strongly preferred, and every effort should be made to ensure the capability to transfuse blood products is available near the point of injury. Survival is improved when blood products are transfused within about 30 minutes of injury.[25]

Resuscitation products of choice for casualties in hemorrhagic shock, listed from most to least preferred, are:

- Whole blood
- Plasma, red blood cells (RBCs), and platelets in a 1:1:1 ratio
- Plasma and RBCs in a 1:1 ratio
- Plasma or RBCs alone
- Crystalloid (lactated Ringer's or Plasma-Lyte A).

***Caution**: Crystalloids or Hextend are therapies of last resort and can worsen coagulopathy and bleeding. They should be used only in severely bleeding patients with no radial pulse when no blood products are available. Every effort should be made through training and preparation to ensure availability of stored blood products and ability to draw FWB.*

USE OF WHOLE BLOOD DURING RESUSCITATION

WB PRODUCTS

WB products listed from most to least preferred:

- **Best:** Low-titer group O whole blood (LTOWB) for all
  - Food and Drug Administration–compliant LTOWB supplied by the Armed Services Blood Program.
  - LTOWB drawn from prescreened donors at deployed location, either before mission or during combat casualty care.
    - ***Identify LTOWB donors before deployment.*** Test all personnel with group O blood for anti-A and anti-B antibodies; low titer is defined as immunoglobulin M anti-A and anti-B ratio less than 1:256.
    - Test for transfusion transmitted diseases (TTDs) before deployment and maintain a roster of donors while deployed. Repeat TTD testing every 90 to 120 days when possible.
    - If adequate staff available, confirm ABO group of LTOWB donor prior to transfusing patient using Eldon card or other approved ABO testing kit. If the wrong blood group is transfused, there is a possibility of fatal transfusion reaction.
- **Better:** Administer group-specific WB from prescreened donors
  - Group A to group A, group O to group O and LTOWB for group B and group AB.
  - Group specific for all ABO Group
  - The ABO group of the patient must be confirmed using Eldon card or other approved ABO testing kit. If the wrong blood group is transfused, there is a possibility of fatal transfusion reaction.
- **Minimum:** when prescreened donors for LTOWB or group-specific WB are not available, identify unscreened donors using an Eldon card or other approved ABO testing kit. If the need arises to use blood from unscreened donors. See Appendix B.
  - Group specific (if adequate staff are available, perform testing and verify with second round of testing (i.e. two Eldon cards by two providers for both donor and recipient to be sure that groupings are correct); if the wrong blood group is transfused, there is a possibility of fatal transfusion reaction).
  - If adequate staff or supplies not available or in chaotic situations, use group O for any patient (possibility of transfusion reaction if not titer tested; however, less likely to result in acute hemolytic transfusion reaction than mistaken group-specific transfusion).

Note: *If blood-group testing has not been performed on the casualty before receiving LTOWB, it may not be possible to establish the underlying blood group and they should only receive universal donor blood products. Every effort should be made to obtain a blood sample for later typing before transfusion of LTOWB.*

When WB cannot be obtained, resuscitation using blood products should proceed according to the order of priority for fluid administration, targeting an equal balance of all blood products that are available (RBCs, plasma, platelets).

TRANSFUSION NOTES

- If time and staffing permit, utilize rapid TTD test kits when prescreened donors are not available. Priority for testing should be for HIV and/or any disease of high significance in local area for which test kits are available.

- During resuscitation, blood products and fluids should be warmed using a fluid warmer and infused rapidly.
- WB can be collected and transfused as warm, fresh whole blood (WFWB) or cold-stored whole blood (CS-WB). CS-WB will almost always be LTOWB. See WB CPG for more details.[28]
- WFWB may have some advantages for resuscitation in the PFC environment when prescreened donors are available and the tactical situation allows, because WFWB may be associated with improved survival in trauma patients.[3,4,29] However, CS-WB is more completely tested for infectious disease and does not require additional personnel to collect or donate the blood and should be used preferentially when available.
- Blood and blood products should only be administered by personnel who are trained in the proper procedure and the identification and management of transfusion reactions.
- Usually only one unit of FWB should be collected per donor. However, in extremis, two units may be taken from a single donor. Depending on the size and physical fitness of the donor, a two-unit collection may degrade the tactical performance of a donor, whereas a single unit collection will not. If a second unit is collected from the same donor, consider evacuating the donor with the casualty.
- Freeze-dried plasma (FDP) may be administered to initiate resuscitation while obtaining FWB and/or moving the casualty to a location where blood products are available. The indications to give FDP are the same as the indications for transfusion. FDP is a universal blood product that can be given to any blood group.
- See Appendix A for a summary of blood products provided by the Armed Services Blood Program.

HEMOSTATIC ADJUNCTS

GOAL

Use medications to optimize the casualty's ability to form blood clots.

TXA is an antifibrinolytic medication that helps to stabilize blood clots and may improve survival from hemorrhage. TXA should be administered for casualties with signs of hemorrhagic shock and all casualties who meet criteria for DCR within 3 hours of injury. TXA should not be given more than 3 hours after injury, because this has been associated with increased mortality.[10,26,27]

- **Minimum:** Administer TXA-2gm IV as soon as possible after injury (not more than 3 hours after injury).

  Administration of undiluted TXA by slow IV push is acceptable if supplies or tactical situation prevent 100mL IV infusion. Ideally, slow IV push should be given over 10 minutes; however, it may be given faster when the tactical situation indicates, accepting the risk of transient hypotension. Use greater caution when the casualty is already hypotensive before TXA administration.

- **Best:** administer TXA as soon as possible (within 1 hour) after injury. Administer 2gm of TXA IV/IO ASAP, but NOT later than 3 hours

Calcium administration replaces serum calcium lost during hemorrhage and transfusion of citrated blood products. Calcium helps prevent cardiac dysfunction and hypotension.

- **Minimum:** Administer 1gm of calcium IV/IO during or immediately after transfusion of the first unit of blood product.
- **Better:** With ongoing resuscitation, give additional 1g of calcium after every four units of blood product.

- **Best:** Monitor serum calcium during ongoing resuscitation and administer 1g of calcium for ionized calcium less than 1.2mmol/L.

***Caution**: Calcium gluconate is safer for peripheral use. Calcium chloride may cause severe skin necrosis if extravasation occurs through a partially dislodged IV or IO catheter. The risk of bone necrosis with IO injection of calcium chloride is not known. When using peripheral IV or IO access, use extreme caution to ensure the device is in good intravascular position and no extravasation occurs.*

***Caution:** Do not mix medications and blood products in the same IV line. Use a separate line or flush well between giving medications and blood products.*

MONITORING

GOAL

Maintain adequate oxygenation and ventilation, avoid hypotension, trend response to resuscitation.

VITAL SIGNS

Document vital signs frequently (every 15 minutes initially, then every 30–60 minutes once stable for more than 2 hours) on a flow sheet.[30]

- **Minimum:** Document signs and symptoms that could indicate hypovolemic shock and the response to resuscitation in order of early to late appearance in shock.
  - Mental status
  - Respiratory rate
  - Heart rate
  - Peripheral pulses
  - Blood pressure
  - Also document temperature and pulse oximetry
- **Better:** In addition to minimum requirements, monitor capnometry (displaying end-tidal CO_2 ($ETCO_2$) value, ideally with waveform).
- **Best:** Portable monitor providing continuous vital signs display; capnography

URINE OUTPUT

Urine output (UO) is a valuable indicator of adequate resuscitation from hemorrhagic shock.

- **Minimum:** If patient can void, capture urine in premade or improvised graduated cylinder.
  - Collect all spontaneously voided urine and carefully measure; more than 180mL every 6 hours is adequate for adults.
  - A Nalgene® (Thermo Fisher Scientific, http://www.nalgene.com/) water bottle is an example of an improvised graduated cylinder.

- **Best:** Place Foley catheter and record UO hourly.

LABORATORY TESTS

The utility of laboratory tests in the field setting should not be overlooked for simpler and readily available measurements, like UO. When a portable laboratory device is used, it may be useful to trend the following laboratory test values along with vital signs and UO to obtain a more exact clinical picture.

- **Minimum:** None
- **Better:** Check initial point-of-care lactate concentration.
- **Best:** Monitor one or more of the following laboratory values every 60 minutes until the patient is stabilized, then every 6 hours:
  - Lactate
  - pH and base deficit
  - Hemoglobin/hematocrit
  - INR

Note: *Neurologic examination and vital signs trends are essential to identifying a deteriorating patient with traumatic brain injury (TBI). Monitoring $ETCO_2$ is critical for patients with severe TBI. Ensure this capability is available.*

ASSESSING RESPONSE TO RESUSCITATION

OVERVIEW

Assessing response to resuscitation is a **dynamic process** that is most accurate when all available data are used to paint a composite picture of the casualty. This whole picture is more accurate than any single normal (or abnormal) component.

Casualties will follow one of three trajectories in response to resuscitation: responder, transient responder, or nonresponder.

1. **Responder:** Clinical and objective trends improve after resuscitation and remain stable.
2. **Transient responder:** Trends improve after resuscitation, then decline. This decline should prompt reassessment of hemostatic procedures, assessment for missed hemorrhage, assessment of acidosis or hypothermia, and a trial of repeated resuscitation. If bleeding and factors that affect coagulopathy are controlled, transient responders will likely respond to more resuscitation. A subset of transient responders includes casualties with slow, noncompressible hemorrhage for whom resuscitation can "keep up" with blood loss until surgical hemostasis can be obtained, provided casualty has access to enough blood products and surgery can be obtained.
3. **Nonresponder:** Trends do not improve or continue to worsen after initial trial of resuscitation. Before declaring a casualty to be a nonresponder, reassess hemostatic procedures, assess for missed sources of bleeding, and decompress both sides of the chest (needle decompression/finger thoracostomy/tube thoracostomy). Assess for pericardial tamponade by ultrasound or as a last resort, blind

pericardiocentesis. If major bleeding cannot be controlled, it is not likely that the casualty will respond; this includes noncompressible torso hemorrhage where it is not possible for resuscitation to replace blood loss. If factors affecting coagulopathy (e.g., acidosis and hypothermia) cannot be corrected (with resuscitation and rewarming), it is also unlikely that the casualty will respond.

Note: *If a casualty does not respond to resuscitation, a decision must be made whether to continue resuscitative efforts. If the casualty has worsened, further resuscitation is likely futile. If they have not responded but not worsened, a trial of additional resuscitation if resources are available can be considered to assess whether the initial resuscitation was insufficient.*

Managing a nonresponding casualty is a complex decision that must balance availability of medical resources, demand of other casualties (or contingencies) for those resources, ability of the team to continue the effort of resuscitation, and other factors. It is highly advised to manage in consultation with medical experts (e.g., by telemedicine discussion).

END POINTS OF RESUSCITATION

GOAL

Determine when to stop administration of blood products. It may be difficult to determine when to stop resuscitation and transition to maintenance monitoring and care. Patients may have abnormal vital signs for many reasons. Obtain teleconsultation if targets are not being met and/or trending in the wrong direction.

- **Minimum:** Identify clinical stabilization through ongoing monitoring and examination.

  Slowing heart rate, palpable peripheral pulses, brisk capillary refill, warming extremities, improving mental status (if no brain injury), slowing/cessation of coagulopathic bleeding (wounds and/or IV site bleeding).

- **Better:** In addition to minimum, recognize improved vital signs and objective criteria.
  - **SBP at goal**
    - Goal SBP is approximately 100mmHg if resuscitating with blood products (maintain mild hypotension until definitive bleeding control).
    - In patients with traumatic brain injury, goal SBP is greater than 110mmHg.
    - If unable to resuscitate with blood products, a lower blood pressure goal of SBP from 80–90mmHg is acceptable.
  - **Oxygen saturation** (Spo2) at least 90% (SpO2 >96% is not necessary),[32] fraction of inspired oxygen (Fio2) required should be less than 50%
  - **Temperature** greater than 95ºF (35ºC)
  - **UO** greater than 30mL/h or greater than 0.5mL/kg/h o
- **Best:** In addition to minimum and better, confirm that hemorrhagic shock is resolving, using the following laboratory values:
  - Hemoglobin concentration greater than 8.0g/dL

- Hematocrit greater than 27%
- Lactate concentration less than 2.5mmol/L
- Base deficit less than 4 (base excess greater than −4)

Note: *Improving trends are as important as meeting absolute goals when assessing response.*

If laboratory values do not improve or trend in the wrong direction for two or more different values, either additional resuscitation and/or hemorrhage control interventions are needed or the injury is not survivable given resources and capabilities available. Consider teleconsultation. Expectant management may be appropriate in some circumstances.

DOCUMENTATION

Documentation should consist of the following:[30]

- **Minimum:** TCCC Card (DD1380)
- **Better:** PFC flowsheet

During prolonged care, once all available time blocks on the TCCC card are filled and evacuation to higher level of care is not imminent, transition to PFC flowsheet.

- **Best:** After action report in addition to above

Note: *Blood products transfused, patient and donor identification must be reported to the COCOM Joint Blood Program Office (JBPO). Recipients of emergency collected whole blood must be enrolled into a follow-up infectious disease monitoring program (contact JBPO or ASBP for guidance).*

PEDIATRIC CONSIDERATIONS

- Critically wounded or ill pediatric patients are more difficult for the Role 1 provider or medic because of the lack of regular exposure to pediatric care. It is recommended that a pediatric reference card or Broselow tape be available to identify pediatric ranges for vital signs, drugs, and supplies.
- Total circulating blood volume in children can be estimated at 70–80mL/kg for children younger than age 12 years.[31] In very young or small children, this is a very small volume. For example, an average 1-year-old American child weighs 10–11kg and has a total blood volume approximately equivalent to two units of blood. Underestimating blood loss percentage and over resuscitating should both be avoided.
- As in adults, do not hesitate to use an IO catheter as the first and primary line for initial resuscitation. A second IV or IO line should be started as soon as possible for additional drug administration.
- TXA is indicated in pediatric casualties. The dose is 15mg/kg TXA loading dose (maximum, 1g) over 10 minutes followed by 2mg/kg/h for 8 hours (maximum, 1g).[33]

To prepare the second dose as a drip, inject 15mg/kg TXA into a 100mL bag of NS. Using a dial-a-flow drip set, place the drip rate at 13 mL/h (OR by drip count: 1 drip every 5 seconds for 60 drip/mL tubing; 1 drip every 18 seconds for 15 drip/mL tubing; 1 drip every 27 seconds for 10 drip/mL tubing).

- Similar to adults, early transfusion therapy should be started sooner rather than later. LTOWB and FWB are both acceptable to give to children with life-threatening hemorrhage. There is no contraindication to

the use of any WB product in children. The initial dose for blood is 10mL/kg, but in children with massive hemorrhage, blood products can be given in higher doses as fast as needed to gain hemodynamic stability. Massive transfusion in pediatrics has been defined as more than 40mL/kg of blood products in 24 hours. WB is easier to titrate effectively in children than component therapy.

- Children are at high risk of developing hypocalcemia, hypomagnesaemia, metabolic acidosis, hypoglycemia, hypothermia, and hyperkalemia during transfusion. Therefore, frequent monitoring (every hour if possible) and correction of acid/base status, electrolytes, and core temperature is indicated during the resuscitation of pediatric casualties, when available.

END OF LIFE/EXPECTANT MANAGEMENT

Determining futility of care: despite best efforts, certain injuries are not survivable in austere environments. The tactical situation, casualty clinical condition, and operational constraints (e.g., mass casualty incidents, logistics) may warrant the consideration of ceasing ongoing, aggressive resuscitative efforts.

The provider must use all their operational knowledge to determine the utility of ongoing resuscitation. As a guide only, examples of wounds with low chance of survival include:

- Cranial injuries with exposed brain matter (exception may be isolated frontal lobe injuries) or severe TBI with signs of herniation (i.e. dilated pupils, hypertension plus bradycardia) or Glasgow Coma Scale score .[3–5]
- Penetrating thoracic or abdominal injuries that are hypotensive or nonresponsive after:
  - two units blood transfusion
  - bilateral chest decompression (needle decompression/finger thoracostomy/tube thoracostomy)

    and
  - assessment for pericardial tamponade
- Junctional amputations with pelvic disruption
- Out-of-hospital cardiac arrest (despite bilateral chest decompression), especially if surgical resuscitation is more than 10 minutes away.
  - Blunt trauma mechanism without organized activity on cardiac monitor
  - Cardiopulmonary resuscitation for longer than 5 minutes
  - No cardiac motion observed on FAST examination or palpated with left finger thoracostomy
  - Cardiac monitoring reveals:
  - Asystole
  - No organized rhythm
  - Wide complex/idioventricular rhythm
- Cervical spine trauma with cardiovascular collapse
- Obvious massive trauma, such as total body disruption and decapitation
- Nonresponders

Before cessation of resuscitation attempts by the provider, every attempt should be made to contact medical direction for input. If contact with higher medical direction is not feasible, then the on-scene provider must use

their best judgment for ongoing resuscitation attempts. This may include an assessment of available resources, timing of evacuation, and the clinical condition of all the patients requiring the attention of the provider making the decision. It will not always be possible to save all team members.

A determination that further attempts to save a life are futile does not necessarily mean cessation of clinical care for the patient. All reasonable interventions to reduce pain and suffering, short of hastening death (e.g., not giving a lethal dose of opiates) should be provided. At times, agonal respirations and bodily movement can take place in the dying process; be prepared for this in the sight of comrades and be prepared to explain this. This is not a reason to continue resuscitative efforts.

If a casualty dies, all medical interventions should be left in place if feasible. If supplies may be needed for future casualties and resources are critically limited, it may be necessary to reuse medical devices (e.g., cricothyrotomy kits, chest tubes).

After death, a casualty should not be used as a blood donor for surviving casualties. Every attempt should be made to find alternate donors for any surviving casualties. Transfusing blood from a deceased casualty may result in transfusing acidotic and hypocoagulable blood, thus worsening the surviving casualty's hemostatic physiology and possibly causing death.

Providers facing the dilemmas around patient death and cessation of resuscitative efforts should also be cognizant of the effects on team members, other patients, and on themselves. Various strategies for coping with these challenges may be appropriate in different circumstances. A full exploration of the topic is beyond the scope of this CPG; however, some consideration of these issues should be built into individual and unit training for PFC scenarios.

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APPENDIX A: BLOOD PRODUCTS AVAILABLE – ARMED SERVICES BLOOD PROGRAM

			Temperature for		Transport	
Product	**Volume, mL**	**Shelf Life**	**Storage**	**Transport**	**Bulk: Collins Box (storage requirements)**	**Tactical** (Storage time when preconditioned to −18°C)**
Warm fresh whole blood*	450	24 hours at RT If refrigerated in 8 hours (see CSWB)	1–6°C	N/A	N/A	N/A
CSWB (LTOWB)	450–500	CPD: 21 days CPDA-1: 35 days 24 hours at RT	1–6°C	1–10°C	21 units/each ~14lb wet ice every 48 hours	2 units (24–48 hours)
Red blood cells	310	CPD/AS5: 42 days CPDA-1: 35 days	1–6°C	1–10°C	30 units (~14 lb wet ice every 48 hours)	2-4 units depending on container (24–48 hours)
Frozen plasma	220	Frozen: 1 year	Frozen: ≤–18°C	Frozen: maintain frozen	Frozen: 15 units (~20–30lb dry ice every 48 hours)	Frozen: N/A
		After thawing: 5 days if stored at 1–6°C	Thawed: 1–6°C	Thawed: 1–10°C	Thawed: 30 units (~14lb wet ice every 48 hours)	Thawed: 2–4 units depending on container (24–48 hours)
Liquid plasma	220	CPD: 26 days CPDA-1: 40 days	1–6°C	1–10°C	30 units (~14lb wet ice every 48 hours)	2-4 units depending on container (24–48 hours)
Platelets, RT	150–400	7 days	20–24°C	20–24°C	N/A	N/A
Platelets, cold-stored	150–400	10 days	1–6°C	1–10°C	4 units (~14lb wet ice every 48 hours)	2 units (24–48 hours)
Cryoprecipitate	15 (single) 150 (pooled)	Frozen (single & pooled): 1 year	Frozen: ≤–18°C	Frozen: maintain frozen	Frozen: 15 units (~20–30lb dry ice every 48 hours)	N/A
		Thawed: within 6 hours thawed or 4 hours pooled if stored at 20–24°C	Thawed: 20–24°C			
Freeze dried plasma***	220 ml reconstituted	2 years	12–25°C	Ambient temperature	N/A	N/A

CPD, citrate-phosphate-dextrose; CPDA-1, citrate-phosphate-dextrose-adenine; CSWB, cold-stored whole blood; LTOWB, low-titer group O whole blood; RT, room temperature; N/A, not applicable.
*Approximate distribution of blood types in US population: type O, 45%; type A, 40%; type B, 11%; type AB, 4%.
**Tactical blood storage: Options include Golden Hour Container, Golden Hour Medic Container. Other transport containers may also be available. Ensure all blood transport containers are validated for use in coordination with Army Services Blood Program.
***The US Food and Drug Administration granted an emergency use authorization for French freeze-dried plasma to the US military on 9 Jul 2018, however supply is limited.

APPENDIX B: UNSCREENED DONOR PROCEDURES

When an emergency situation does not allow complete donor assessment according to the Joint Trauma System Whole Blood Transfusion Clinical Practice Guidelines,[13] the following rapid donor screen may be used. Relaxing the donor acceptance criteria will increase the risk of transfusion-transmitted disease. The decision is a risk-benefit analysis.

Primary Triage (question as a group)

Serial	Question	Yes	No	Action
1	Do you want to give blood?			Disqualify if NO
2	Have you given blood before?			If YES, consider early selection
3	In the past 48 hours, have you taken aspirin, Motrin, or other NSAID?			If YES, donor priority is after those who answer NO

Secondary Triage (question potential donors individually)

Serial	Question	Yes	No	Action
4	Are you unwell now? New fever/diarrhea/vomiting Chronic medical condition and not well			Disqualify if YES
5	Have you ever had cancer, heart problems, bleeding conditions, or lung disease?			Disqualify if YES
6	Have you had a blood transfusion or blood products in the last year?			Disqualify if YES Accept after 1 year
7	Are you living with hepatitis B or C, HIV/AIDS, OR living with anyone with these conditions?			Disqualify if YES
8	Have you ever been refused as a donor or told not to donate blood? (A past history of treated anemia may be acceptable)			Disqualify if YES
9	Male donors only: Have you ever had sex with another male?			Disqualify if YES
10	Have you ever used needles to take drugs, steroids, or anything not prescribed by your doctor?			Disqualify if YES
11	Are you currently pregnant or breastfeeding?			Disqualify if YES
12	Conduct a physical examination. Check: temperature/rash/ malnutrition/pallor/jaundice/cyanosis/shortness of breath/ intoxication from alcohol or drugs/veins			Disqualify any potentially unwell donor or donors with very difficult veins
13	Have you ever had Malaria, Chagas, or Babesiosis?			Disqualify if YES
14	Have you ever received money, drugs, or other payment of sex?			Disqualify if YES

Risk Triage (question potential donors individually)

Score	Questions	Subtotal	Notes
Blood donation history			
1	Regular donor		Optimum
2	Previous donor		
3	Nondonor		
Veins and body weight			
1	Good lateral (outer) vein		Optimum
2	Poor or difficult vein		
3	<60kg		
Travel			
1	No travel in the countries below in the last 6 months		Optimum
2	South America		
4	Asia and Africa		
Lifestyle			
1	Sex with one partner		Optimum
3	Sex with multiple partners but protected		
—	Sex with a sex worker or in exchange for money/drugs		Avoid for 12 months
Serious medical conditions			
1	None		Optimum
3	Past or present serious medical conditions but managed and well		
3	Untreated current medical conditions but well		
	TOTAL		

Add up score and record total: Lowest score = Lowest risk. Use point-of-care test for transfusion transmitted infections. Eliminate and counsel any positives. Blood type donor and recipient and document results.

APPENDIX C: WHOLE BLOOD DRAW AND STORAGE PLANNING GUIDE

(Provides for 25 whole-blood collections from donors and 25 recipients)

Donor Testing	Transfuse to Patient

• Eldon military kit
  - 2 x Eldon bags, 50 Eldon cards
  - 200 x Eldon sticks
  - 50 x Standard lancets
  - 50 x Skin cleansing swabs
  - 50 x Cotton balls
  - 2 x Plastic droppers
  - 2 x Set of instructions
• 25 x 10mL prefilled NS syringe
• 25 x Point-of-care disease testing kit
  - HIV, HCV, HBV, RPR, malaria, area specific (e.g. Ebola)
• 50 x red top and 100 x purple top tubes for confirmatory laboratory testing
• 2 x Permanent marker
• 5 x Nitrile glove, L
• 2 x Surgical tape
	• Fluid warming device
	• 25 x IV catheter, 18G x 1.25"
	• 25 x IO catheter, 18G
	• 25 x 100mL NS
	• 25 x Y-type administration set with filter
	• 2 x Pressure infusing device
	• 25 x OPSITE wound dressing

Donor Blood Draw	**Monitor Patient**
• 25 x Single collection 450mL CPD/CPDA-1 blood pack • 25 x 1mL syringes with 25G needles • 5 x Kelly forceps for tube clamping • 1 x 10" 550 cord • 200 x Alcohol pads • 25 x 18G needle • 200 x Woven gauze sponges • 25 x OPSITE wound dressing • 25 x Blood bag labels	• 2 x Thermometer • 1 x BP cuff • 1 x stethoscope • 2 x Spo_2 monitor • 2 x CO_2 monitor • 2 x Foley catheter
Storage	**Drugs**

• Cooling unit (maintain 6°C)
• White board (to record blood types and draw dates)
	• 10 x 1:1,000 epinephrine
	• 10 x 50mg diphenhydramine
	• 10 x 1g calcium
	• 25 x gm TXA
	  - 25 x 10mL syringe
	  - 25 x 18G needle
	  - 25 x 100mL NS
	  - 25 x administration set

APPENDIX D: DAMAGE CONTROL RESUSCITATION IN PROLONGED FIELD CARE: SUMMARY TABLE

Goal	Minimum	Better	Best
Recognizing casualties who require DCR			

Recognize patients with traumatic hemorrhage who will benefit from early DCR.	Initial survey, recognize need for DCR based on:
	• Severe injury pattern: proximal, bilateral, or multiple amputations; penetrating injury to chest/abdomen; pelvic or junctional hemorrhage
	• Altered mental status (in absence of TBI)
	• Weak/absent radial pulse
		If initial survey does not indicate severe blood loss, continue to assess for signs of shock:
		• SBP <100mmHg
		• Pulse >100 bpm
		• Physiologic signs of shock (e.g., cool extremities, delayed capillary refill)
		• Clinical signs of coagulopathy (e.g., bleeding from minor wounds such as IV or IO sites)
			If uncertain, confirm using laboratory and/or imaging studies.
			Predictors of massive transfusion (more predictors = higher risk)
			• Penetrating mechanism
			• Positive FAST examination (especially if 2 or more regions)
			• Initial lactate >4mmol/L
			• Base deficit >6mEq/L
			  • pH <7.25
			  • INR≥1.5

– Do not delay initiating DCR if hemorrhagic shock is clinically suspected			
Hemorrhage control			
Stop external hemorrhage and reduce internal hemorrhage per TCCC guidelines.	• Limb tourniquets • Wound packing • Pressure dressings • Hemostatic dressings • Junctional tourniquets • Pelvic binders		Emerging technologies: • AAJT • REBOA • ≤30 minutes inflation time, see protocol for use.
Resuscitation—products of choice for casualties in hemorrhagic shock, listed from most to least preferred			
• Whole blood • Plasma, RBC, and platelets in a 1:1:1 ratio • Plasma and RBCs in a 1:1 ratio		• Plasma or RBCs alone • Crystalloid (lactated Ringer's or Plasma-Lyte A)	

Goal	Minimum	Better	Best
Resuscitation—use of whole blood			
Maintain vital-organ perfusion and minimize acute coagulopathy of trauma through administration of WB within 30 minutes of injury.	When prescreened donors or LTOWB are not available, transfuse: • Type-specific WB (verify using Eldon card x2; if wrong blood type transfused, possibility of fatal transfusion reaction). • If adequate staff or supplies not available or in chaotic situations, use Group O WB for any patient (possibility of transfusion reaction if not titer tested).	Type-specific WB drawn from prescreened donors in the following order of preference: • Group A to Group A, Group O to Group O and LTOWB for Group B and Group AB. • Type specific for all ABO Groups.	LTOWB for all • FDA-compliant cold-stored LTOWB drawn from prescreened donors • LTOWB drawn from prescreened donor at deployed location, either before mission or during combat casualty care
Hemostatic adjuncts			
TXA			
Administer TXA early after injury to reduce fibrinolysis and stabilize clot.	TXA 2g IV as soon as possible after injury. May administer undiluted by slow IV push when necessary.		• TXA -2gm IV as soon as possible after injury
*– TXA should be administered for casualties with signs of hemorrhagic shock and all casualties who meet criteria for DCR within 3 hours of injury. TXA **should not** be given more than 3 hours after injury. **Rapid IV push may cause hypotension.***			
Calcium			
Maintain calcium levels lost during hemorrhage and transfusion of citrated blood products to prevent cardiac dysfunction and hypotension.	Administer 1g of calcium IV/IO during or immediately after transfusion of the first unit of blood product.	With ongoing resuscitation, give additional 1g of calcium after every four units of blood product.	Give initial dose then monitor serum calcium level during ongoing resuscitation and administer 1g of calcium for ionized calcium level <1.2mmol/L.
– Calcium gluconate is safer for peripheral use. Calcium chloride may cause severe skin necrosis if extravasation occurs through a partially dislodged IV or IO. The risk of bone necrosis with IO injection of calcium chloride is not known. When using a peripheral IV or IO catheter, use extreme caution to ensure that the device is in good intravascular position and no extravasation occurs. ***– Do not mix medications and blood products in the same IV line. Use a separate line or flush well between giving medications and blood products.***			

AAJT, Abdominal Aortic and Junctional Tourniquet; CPD, citrate-phosphate-dextrose; CPDA-1, citrate-phosphate-dextrose-adenine; CPG, clinical practice guideline; DCR, damage control resuscitation; $EtCO_2$, end-tidal CO_2; FAST, focused assessment with sonography for trauma; FDA, Food and Drug Administration; HBV, hepatitis B virus; Hct, hematocrit; HCV, hepatitis C virus; INR, international normalized ratio; IO, intraosseous; IV, intravenous; LTOWB, low-titer group O whole blood; NS, normal saline; PFC, prolonged field care; RBC, red blood cell; REBOA, resuscitative endovascular balloon occlusion of the aorta; SBP, systolic blood pressure; Spo_2, oxygen saturation; TBI, traumatic brain injury; TCCC, Tactical Combat Casualty Care; TXA, tranexamic acid; UO, urine output; WB, whole blood.

Goal	Minimum		Better	Best
Monitoring				
Vital signs	• Mental status • Blood pressure • Respiratory rate • Heart rate	• Peripheral pulses • Pulse oximetry • Temperature	Minimum + capnometry	Portable monitor with continuous vital signs display; capnography
UO goal: UO ≥30mL/h (or 0.5mL/kg/h)	Collect all spontaneously voided urine and carefully measure; >180mL every 6 hours is adequate for adults.			Place Foley catheter and record UO hourly.
Laboratory tests	None		Check initial POC lactate level	Lactate, pH, base deficit, hemoglobin/ Hct, INR measured every 60 minutes until stabilized, then every 6 hours
– Neurologic examination and vital signs trends are essential to identifying a deteriorating patient with TBI. – Monitoring $EtCO_2$ is critical for patients with severe TBI; ensure this capability is available.				
Assess response to resuscitation				
• Responder: Clinical and objective trends improve after resuscitation and remain stable. • Transient responder: Trends improve after resuscitation, then decline. • Nonresponder: Trends do not improve or continue to worsen after initial trial of resuscitation (see End-of-life/expectant management in CPG text).				
End points of resuscitation				
Determine when to stop administration of blood products and transition to maintenance monitoring and care.	Clinical stabilization indicated by: • Slowing heart rate • Improved peripheral pulses, brisk capillary refill • Warming extremities • Improving mental status (if no TBI)		In addition to minimum, recognize improved vital signs and objective criteria. • SBP at goal • SpO2 >92%, FiO2 required <50% • Temperature >95ºF (35ºC) • UO >30 mL/h or >0.5mL/kg/h	In addition, confirm by laboratory values that hemorrhagic shock is resolving. • Hemoglobin >8.0 g/dL • Hematocrit >27% • Lactate <2.5mmol/L • Base deficit <4
– Goal SBP ~100mmHg if resuscitating with **blood products**; if unable to resuscitate with blood products, goal SBP is 80–90mmHg. In TBI, goal SBP >110mmHg**.** – Obtain teleconsultation if goals are not being met and/or trending in the wrong direction.				
Documentation				
Adequately capture clinical information to ensure continuity of care	TCCC Card (DD1380)	PFC flowsheet: once all time blocks on the TCCC card are filled and evacuation to higher level of care is not imminent, transition to PFC flowsheet.		TCCC care (DD1380) + PFC flowsheet + after-action report
– Blood products transfused, patient and donor identification must be reported to the COCOM Joint Blood Program Office (JBPO). Recipients of emergency collected whole blood must be enrolled into a follow-up infectious disease monitoring program (contact JBPO or ASBP for guidance).				

APPENDIX E: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

The Prevention of Deep Venous Thrombosis – Inferior Vena Cava Filter (CPG ID: 36)

To establish guidance for 1) anti-thrombotic therapy for the prevention of deep venous thrombosis (DVT) and pulmonary embolism (PE) and 2) the management of inferior vena cava filters (IVCs) placed in the combat theater for the purpose of either primary or secondary prophylaxis of pulmonary embolism.

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BACKGROUND

Trauma patients are known to be at high risk for Venous Thromboembolism (VTE) including Deep Venous Thrombosis (DVT) and Pulmonary Embolism (PE). Major trauma patients can have up to 58% incidence of DVT.[1] Sevitt and Gallagher reported an even higher incidence (65%) in injured and burned patients and reported a 16.5% incidence of PE found at autopsy in this cohort of patients.[2,3]

In addition to the hypercoagulable state induced by severe injury in trauma, combat casualties have additional risk factors for DVT, including:[1,4-8]

- Early transfusion of blood products (≤24 hours);
- Transfusion of old blood (≥28 days);
- Multiple and/or above the knee amputations

The use of Fresh Frozen Plasma (FFP) outside of large volume blood product transfusion (less than 4 U PRBC's) incurs an increased risk of VTE.[9] Early prophylaxis in this patient population is recommended provided hemostasis has been achieved.

The nature of the current combat theater has provided our deployed medical team's ample opportunity to care for children injured as non-combatants. The incidence of DVT after trauma is much lower (6.2%) than that of adults in the civilian literature.[10] The presence of multiple risk factors including immobility and central venous line, however, were associated with the development of DVT in pediatric trauma patients.

There is an increasing recognition of DVT in individuals who complete an extended period of travel on an airplane. One study noted a 10% prevalence of asymptomatic DVT in individuals undergoing flights of 8 hours or more.[11] Combat casualties are at high risk for VTE during recovery and evacuation, which can be associated with long flights and immobility, thus it is important to start VTE prophylaxis as soon as clinically possible.[12]

Landstuhl Regional Medical Center is uniquely positioned to receive patients who have undergone extensive periods of travel prior to admission.

Different medical societies and working groups have published varying recommendations for DVT prophylaxis.[13,14] The clinical guidance recommended here represent the guidelines with either a higher level of scientific evidence supporting the recommendation, or the more conservative recommendation. It is recommended to begin DVT prophylaxis therapy as soon as coagulopathy is corrected in patients not otherwise at increased risk of bleeding.

RECOMMENDATIONS FOR DVT PROPHYLAXIS

Unless contraindicated by lower extremity injury, all trauma patients should receive:

1. Sequential Compression Device (SCD) therapy as primary DVT prophylaxis in addition to;
2. Low dose Unfractionated Heparin (UFH)[13-15]; or
3. Low Molecular Weight Heparin (LMWH), Enoxaparin 30mg subcutaneous (SC) twice daily.[16]
4. Alternatively, low does LMWH such as Dalteparin 5000 U SC or Enoxaparin 40mg SC can be given daily and in one study has a lower incidence of DVT when compared to 30mg BID dosing in post-operative patients.[14,17,18]

5. Unfractionated Heparin (5000 U) administered subcutaneously three times daily has been demonstrated to be as effective as or at least non-inferior to Enoxaparin in the prevention of DVT in trauma patients.[19,20]

Consideration should be given to the use of LMWH in patients with impaired renal function (CrCL=30ml/min or less), as there is a concern for LMWH accumulation and increased risk of bleeding.

1. Despite this concern, no clear evidence exists for dose modification or contraindication to the use of LMWH for DVT prophylaxis in renal impaired patients.[21]

2. Godat et al. reported, however, that trauma patients who are considered to be at the highest risk to develop VTE (especially spinal cord injury with/without pelvic fracture) are at the greatest risk during the first three months after injury and that this risk decreases at six months post injury.[23]

The role of **duplex ultrasound** in the diagnosis of DVT should be reserved for the symptomatic patient. Serial screening duplex ultrasound for the diagnosis of DVT is not recommended.[14]

CHEMICAL DVT PROPHYLAXIS

Provided coagulopathy and ongoing bleeding is corrected, chemical DVT prophylaxis (<48 hours post injury) has been shown to be safe after blunt solid organ injuries.[24,25]

Chemical DVT prophylaxis (<48-72 hours) following traumatic brain injury with intracranial hemorrhage does not increase the progression of intracranial bleed.[26,27] Prior to starting chemical DVT prophylaxis, you should:

1. Consult a Neurosurgeon.

2. Obtain a stable CT scan of the head at 24 hours post injury.

Prophylaxis should be withheld in the setting of progression of intracranial hemorrhage or presence of an intracranial monitor.

Modification of enoxaparin dosing to 40mg daily in the combat casualty requiring an epidural pain catheter does not increase the incidence of venous thromboembolism.[28]

Inferior Vena Cava Filter (IVCF) placement in the combat theater may be used for:

1. Primary Prophylaxis (no evidence of VTE disease at the time of placement).

2. Secondary Prophylaxis (documented DVT) of PE in the polytrauma patient.

Patients felt to be at particularly **high risk for VTE development** and who have a clinical contraindication to prophylactic anticoagulation are the most likely to have an IVCF placed.

Most series examining the use of **IVCF placement for primary prophylaxis of PE** in the trauma patient support a low rate of subsequent PE (1.6%), although the studies are of variable design and a strong consensus supporting this clinical practice cannot be made based upon available data.[29]

There is no evidence that **prophylactic use of IVCF** is associated with a decreased PE rate or fatal PE rate. It should be noted that when IVCF are placed they are done so to prevent FATAL Pulmonary Emboli as DVT and PE still can occur.[30-34]

IVCF has no benefit in the prevention of DVTs and may be associated with the development of IVC and Deep Venous Thrombosis.[14,35]

RETRIEVABLE INFERIOR VENA CAVA FILTERS (RIVCF)

The vast majority of IVCF devices placed in the combat theater are Retrievable Inferior Vena Cava Filters (RIVCF).

RIVCF are preferred to avoid some of the long-term complications of filter placement. Additionally, many patients only need this form of VTE prophylaxis for a defined period of time early after injury.

Despite successful removal of IVCF beyond 180 days and high success and low complication rate for attempted **IVCF removal**, rates of eventual removal of RIVCFs in multiple studies of trauma patients in the United States have been as low as 14% to 22%.[36,37,38,39,40]

Combat injured patients from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) who had RIVCFs placed have an overall retrieval rate of 18%.[41]

It should be noted however; that the majority of patients was lost to follow up or did not have filters removed due to ongoing indications for use (82%). Therefore, the overall retrieval technical success rate may be much higher. Most series support removal of the most commonly used RIVCFs as early as they are no longer necessary and no later than approximately three months.[42] While it is possible to remove any of these later than this time period, the technical success declines significantly as potential complications associated with removal increase. Clear electronic documentation and a dedicated tracking system at the final CONUS MTF must be in place to improve retrieval rates and minimize loss to follow up.[43]

EDUCATION AND TREATMENT

Refer to Appendix A for specific guidance on different subsets of patients after various surgical procedures.

Refer to Appendix B for additional recommendations regarding IVC filters.

AEROMEDICAL EVACUATION CONSIDERATIONS

1. Aeromedical Evacuation (AE) from any area of responsibility to continental U.S. can require multiple flights over the course of days before the patient arrives at his or her final destination.
2. There is a clear association between long-distance travel and an increased risk of VTE, even in a "healthy traveler."
3. Stresses of flight such as prolonged immobility and decreased humidity may contribute to VTE formation, especially in groups who already carry a high risk (trauma patients, recent surgeries, long bone fractures, smokers, pregnancy or post-partum, recent Myocardial Infarction, active cancer, presence of splint or cast, etc.).
4. Prophylaxis is essential to reduce the risk of VTE associated morbidity and mortality in all AE patients.
   a. AE crews will encourage patient ambulation every 2 hours for patients whose condition allows.
   b. SCD use should be universal for inpatients unless contraindicated by injury pattern. The Kendal SCD Express compression system is approved for use on military aircraft.
   c. Chemical VTE prophylaxis is also recommended as above for all trauma or medical inpatients unless specifically contraindicated by the medical condition such as ongoing bleeding or coagulopathy.
5. AE Patients with KNOWN acute VTE should be treated prior to flight unless there is a clear contraindication.
   a. Treatment depends on the clinical situation, but may include low-molecular-weight Heparin, Fondaparinux, oral Xa inhibitors, or Unfractionated Heparin.
   b. Oxygen and continuous pulse-oxygenation monitoring should be available during AE for patients with known VTE in case supportive measures are needed.
   c. In the case of known or suspected Pulmonary Embolism, a Cabin Altitude Restriction should be considered to mitigate the effects of altitude on oxygenation and respiration.

d. Addition of a Critical Care Air Transport Team should also be considered in cases of PE with significant respiratory or hemodynamic compromise.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All trauma patients admitted to Role 2 or higher.

INTENT (EXPECTED OUTCOMES)

1. All patients in population of interest receive DVT prophylaxis with sequential compression device within 24 hours of injury.

2. All patients in population of interest start chemoprophylaxis (Heparin, Lovenox) within 48 hours of injury or contraindication documented.

3. When IVCF is inserted, there is documentation in the medical record regarding the indication for procedure, whether the IVCF is retrievable, manufacturer, brand, serial number, lot number, and exact location of placement.

4. Retrievable IVC filters are removed within 6 months.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who start DVT prophylaxis with sequential compression device within 24 hours of injury.

2. Number and percentage of patients in the population of interest who receive DVT chemoprophylaxis within 48 hours (Heparin, Lovenox) or have contraindication documented.

3. Number and percentage of patients who receive IVC filter placement who have complete documentation of indication for procedure, whether the IVCF is retrievable, manufacturer, brand, serial number, lot number, and exact location of placement.

4. Number and percentage of retrievable IVC filters placed that are removed within 6 months.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief, JTS Program Manager and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

All Health Care Providers will:

- Become familiar with the guidelines for the prevention of DVT (see Appendix A).
- Appropriately manage patients who may be at risk of developing DVT.
- Provide feedback on these guidelines and suggestions for changes to the CPG to the JTS Chief.

The senior surgeon and/or Intensivist at each Role 3 facility will:

- Review all thromboembolic events in the Level III facility to assess ways to reduce the risk to the patient.
- Coordinate with the JTS Performance Improvement Division Chief on the appropriateness of the guidelines being used and provide input for updates on an as needed basis.

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APPENDIX A: PREVENTION OF VENOUS THROMBOEMBOLISM GUIDELINES

RISK GROUP	PROPHYLACTIC MEASURES
TRAUMA PATIENTS	
▪ Emergency trauma surgical procedures in patients with prohibitive risk of bleeding, or ongoing coagulopathy	▪ SCD (sequential compression device) until able to be anticoagulated (ideally start Lovenox within 12 hours of cessation of coagulopathy); see IVC filter and Duplex screening sections below.
▪ Emergency trauma surgical procedures in all patients, except patient with prohibitive risk of bleeding (once coagulopathy not present)	▪ SCD (unless contraindicated by injury) + Lovenox 30 mg SC BID or 40mg SC QD; alternatively Heparin 5000 U SC q 8 hours
▪ Isolated major orthopedic surgery of extremities, spine, and pelvis	▪ SCD (unless contraindicated by injury) + Lovenox 30 mg SC BID
IVC FILTER PLACEMENT	
Patients with: 1. Recurrent PE despite full anticoagulation 2. Proximal DVT and contraindications for full anticoagulation 3. Proximal DVT and major bleeding while on full anticoagulation 4. Progression of iliofemoral clot despite anticoagulation Patients with established DVT or PE and: 5. Large free-floating thrombus in the iliac vein or IVC 6. Following massive PE in which recurrent emboli may prove fatal 7. During/after surgical embolectomy Very High Risk Patients: those who cannot receive anticoagulation because of increased bleeding risk and : 8. Severe closed head injury (GCS<8) 9. Incomplete spinal cord injury with paraplegia or quadriplegia 10. Complex pelvic fractures with associated long-bone fractures 11. Multiple long-bone fractures	▪ Placement of retrievable IVC filter (RIVCF) ▪ **Document if the IVCF is retrievable or not, manufacturer, brand, MRI compatibility, serial number, lot number and exact location** in record and TMDS; PE may still occur despite IVC filter ▪ "Extended" indications for placement of IVC filter for patients with established DVT or PE ▪ Consideration of placement of prophylactic placement of IVC filter.
ROLE OF DUPLEX SCREENING	
▪ Asymptomatic patients	▪ Serial duplex ultrasound imaging of high-risk patients is not recommended.
▪ Symptomatic patients	▪ Duplex ultrasound may be used without confirmatory venography.
GENERAL, VASCULAR, UROLOGIC SURGERY	
LOW RISK:	
Minor procedure in patients < 40 years, no risk factors	Early mobilization
MODERATE RISK:	
▪ Minor procedure with additional risk factors for thrombosis; ▪ Non major surgery in patients 40-60 years, with no additional risk factors; ▪ Major surgery in patients < 40 years with no additional risk factors)	▪ SCD + Unfractionated Heparin 5000 units SCq 8 hours or Lovenox 40 mg SC QD ▪ Chemical DVT prophylaxis is withheld in patients with high risk of bleeding.

RISK GROUP	PROPHYLACTIC MEASURES
HIGH RISK:	
▪ Non major surgery in patients > 60 years or have additional risk factors; ▪ Major surgery in patients > 40 years or have additional risk factors	▪ SCD + Unfractionated Heparin 5000 units SC q 8 hours or Lovenox 40 mg SC QD ▪ Chemical DVT prophylaxis is withheld in patients with high risk of bleeding.
NEUROSURGERY	
▪ Intracranial neurosurgical procedures ▪ High Risk neurosurgery patients	▪ SCD ▪ Chemical DVT prophylaxis following stable CT scan in consultation with neurosurgeon

APPENDIX B: IVCF RECOMMENDATIONS

1. All IVCFs placed in the combat theater should be retrievable.

2. Documentation detailing the ICVF brand, model, MRI compatibility, and exact location of placement should be documented in ALTHA T or TC2.

3. All RIVCFs placed in the combat theater should be removed as soon as contraindications to chemical prophylaxis of VTE disease no longer exist or there is no longer a need for VTE prophylaxis. Exceptions include those that were placed for secondary prophylaxis in a patient who demonstrated new VTE disease while on therapeutic anticoagulation or in patients who are still deemed to be high risk.

4. All RIVCFs should be removed within three months unless a long term indication for their continued use is present.

5. The decision to remove an RIVCF placed in the combat theater (versus leaving it in place permanently) should be made at the first CONUS Level V MTF the patient transitions through while returning from deployment. When possible, the removal should take place at this same facility prior to transition to the next level of care. This approach decreases the chance that a decision will be deferred until removal becomes technically prohibitive.

6. **The presence of a RIVCF in a patient receiving care at the Level IV MTF should be made known to the receiving Level V MTF. Typically, retrieval of the RIVCF will be accomplished at the Level V MTF.**

7. Any patient with a known DVT and without a current contraindication to therapeutic anticoagulation who has an IVCF in place should receive full dose anticoagulation. This is preferably accomplished with Coumadin to target an INR of 2.0-3.0. If further surgical procedures are planned, consideration may also be given to the use of low molecular weight heparin dosed at 1 mg/kg bid or an unfractionated heparin drip until such time as the use of Coumadin is felt to be appropriate.

8. The presence of an IVCF, brand, model, MRI compatibility, whether or not it is retrievable, its exact location and the date of insertion should be clearly annotated in TMDS and again in AHLTA when the patient has returned to the United States.

9. Efforts should be made in the future to standardize the type of RIVCF used at all combat theater locations.

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Documentation in Prolonged Field Care (CPG ID:72)

This CPG is meant to provide medical professionals who treat severely injured or sick patients in austere environments with recommendations for documentation that will allow them and subsequent providers along the evacuation chain to optimally manage complex, often unstable casualties.

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INTRODUCTION

This Role 1, prolonged field care (PFC) Clinical Practice Guideline (CPG) is intended to be used after Tactical Combat Casualty Care (TCCC) guidelines when evacuation to higher level of care is not immediately possible. A provider of PFC must first and foremost be an expert in TCCC. This CPG is meant to provide medical professionals who treat severely injured or sick patients in austere environments with recommendations for documentation that will allow them and subsequent providers along the evacuation chain to optimally manage complex, often unstable casualties. Recommendations follow a "minimum," "better," "best" format that provides alternate methods when optimal hospital options are unavailable.

BACKGROUND

PFC frequently involves the care of complicated, critically injured or sick casualties who are normally managed in medical treatment facilities. For patients that survive the initial trauma or sickness, the biggest risk of death is from circulatory shock and its complications. All severely injured and sick patients must be closely monitored for signs of shock and decompensation because the best treatment for shock is early recognition, treatment of the cause, and resuscitation. One method used by intensive care units to monitor critical patients is trending vital signs, physical exams, and fluid outputs recorded on a flowsheet that facilitates recognition of changes that could mark the early signs of decompensation.

In the PFC environment, one of the few techniques available to the medical provider that is identical to those used in hospitals is documentation of key clinical trends. It is critical that Medics are trained on the interpretation of clinical trends. It is also essential that Medics cross-train nonmedical teammates to take and record vital signs, outputs, key exam findings, and interventions to free the medic to do other tasks as well as to sleep if care of the casualty is especially prolonged.

Documentation that can help the medic and successive caregivers manage complicated patients includes:

- TCCC Card, DD1380
- PFC flowsheet
- Telemedicine guide
- Handoff report

Finally, completion of the PFC after-action report (AAR) will contribute greatly to performance improvement to develop training, tools, and techniques for improving the care of casualties in austere environments.

PATIENT DEMOGRAPHICS

While some casualties will be unable to provide name, identification number, date of birth (DOB), or other identifying information, every effort should be made to collect and document this information in order to facilitate the inclusion of prehospital documentation into the patient's medical record. This information not only helps the longitudinal care of casualties as they progress through the evacuation chain, it also provides the vital link to connect prehospital treatments delivered to survival and long-term outcomes in order to guide recommendations for improving trauma care.

***NOTE**: Medical treatment facilities use pseudo names assigned when a patient's real name is unknown. In such cases, every effort should be made to continue the same pseudo name through transfers of care. Prehospital documentation submitted after patient transfer, to include AARs, should use the same name or pseudo name assigned at the first treating MTF.*

DOCUMENTATION OF PREHOSPITAL CARE

GOALS

- Transmit important medical information to the next level of care
- Permanently record information vital to service members injured in combat
- Contribute to performance improvement in prehospital care.

Minimum: TCCC Card DD1380

- The DD1380 is organized as a MIST (Mechanism, Injuries, Signs and Symptoms, Treatments) report (Appendix A).
- Note the time casualty is received and include time of injury (if known and different from when received) and time of all key interventions (e.g., tourniquet, blood transfusion, tranexamic acid [TXA] dosing).
- List injuries and annotate on the diagram. Tourniquets and tourniquet times are also annotated on the diagram.
- Vital signs, including mental status AVPU (alert or responsive to voice, pain, or unresponsive) and pain scale, should be recorded to the greatest extent possible—up to four sets of vital signs can be recorded on the TCCC card.
- Document treatments to include external hemorrhage control, airway, breathing, fluids, medications, and other interventions on the reverse side of the TCCC card.

Better: PFC Flowsheet

As a follow-on to the TCCC card, the PFC flowsheet is used to document trends over time and is the most useful tool to recognize important clinical changes in complex casualties such as decompensation, response to resuscitation, development of complications, effectiveness of medications, etc. The PFC flowsheet is one of the most effective ways to improve the level of care provided in PFC situations.

- When prehospital care transitions to PFC, documentation should transition from the TCCC card to the PFC flowsheet. There is no exact time for this transition to occur; however, once all of the available time blocks on the TCCC card are filled and evacuation to higher level of care is not imminent, then documentation can transition to the PFC flowsheet (Appendix B).
- The PFC flowsheet not only serves to document care and identify trends but also contains a checklist of interventions that may be needed through the included patient care and nursing care checklists. Such checklists can greatly aid task-saturated, fatigued Medics by providing a quick point of reference for important tasks that should be performed regularly to improve care and reduce the risk of complications to their patients.

- The PFC flowsheet also includes:
  - Vital signs
  - Fluid input and output
  - Medication times, route, dose
  - Physical exam findings
  - Problem list
  - Treatment plan
  - Telemedicine call script

Best: AAR

- An AAR should be completed after patient handoff. In addition to the TCCC card and PFC flowsheet, a structured AAR is used to collect lessons learned and improve care. In cases where documentation is not able to be completed before patient handoff or was lost after handoff, the AAR can also serve as a supplement to the medical record.
- TCCC and PFC AARs are available at https://jts.health.mil/index.cfm/PI_CPGs/cpgs
- TCCC or PFC AARs, along with any medical documentation not completed before patient handoff, should be completed within 24 hours of patient handoff and summited to the Joint Trauma System (JTS) prehospital organizational email box: dha.jbsa.healthcare-ops.list.jts-prehospital@health.mil
- The unclassified medical AAR should be accomplished in addition to unit-required classified AARs.

TELEMEDICINE GUIDE

GOAL

Goal: Facilitate communication between prehospital provider and telemedicine consultant.

Rehearsal of telemedicine consultation between prehospital providers and remote physician consultants has shown that communication is optimized when the caller completes a telemedicine guide or script before calling the consultant and uses it during the consultation. In addition to transmit- ting medical information to the consultant, it is important for the caller to provide information about the care context and a summary of capabilities currently available. An image of the casualty and an image of the care environment are helpful for remote consultants to understand the operational constraints faced by the local caregiver. Capabilities that are important to convey to remote consultants may include the training level of the provider, available medications, medical supplies, monitoring, ultrasound, etc. Reading or sending a photograph of a written capabilities list will more quickly orient the consultant to the operational environment of the caller and reduce time spent asking the caller for items that are not available. If urgent teleconsultation is needed, do not delay calling to fill out a guide sheet or send e-mails. For additional details, see Teleconsultation in prolonged field care position paper.[1]

Minimum: Read from TCCC card.

Better: Use telemedicine report incorporated in the PFC flowsheet.

Best: Use the Virtual Critical Care Consultation guide (Appendix C) and send a picture of casualty, capabilities, and vital sign trends to the consultant via email or text using appropriate operational security and protections of patient privacy.

HANDOFF REPORT

GOAL

Goal: Ensure safe transition to the next level of care.

Adverse events may occur due to poor handover of a patient from one level of care to another. The PFC provider's job is not done until the receiving team understands the patient's condition and can begin to manage the patient appropriately.

Summarize in organized format:

1. Overall condition of the patient: stable or unstable; better, same, or worse.
2. Mechanism of injury or illness
3. Injury(ies), current physical exam
4. Vital signs to include trends and urine output
5. Treatments (procedures, dressings, airway management, fluids, blood products, medications)

Minimum: Written handoff report that follows the MIST format (e.g., TCCC Card).

Better: Add the PFC flowsheet.

Best: Add a dedicated handoff sheet (e.g., SBAR handoff report2, PFC handoff report3).

ELECTRONIC DOCUMENTATION

Electronic documentation is the standard in hospitals and advanced field medical facilities. Devices such as the Tempus Pro (Remote Diagnostic Technologies LTD, United Kingdom) and BATDOK (USAF, 711 Human Performance Wing, OH) are devices designed for the operational environment that can compile detailed patient records that support many of the recommendations in this CPG. These and other similar devices and applications may improve the accuracy of patient records, reduce the burden of data entry for the prehospital provider, and provide other features to improve patient care such as critical value alarms and telemedicine communication. Where such devices are fielded and supported with network connectivity, their use for austere PFC environments is encouraged.

JTS hosts a variety of fillable forms at https://jts.health.mil/index.cfm/documents/forms_after_action

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APPENDIX A: TACTICAL COMBAT CASUALTY CARE CARD, DD 1380

TACTICAL COMBAT CASUALTY CARE (TCCC) CARD

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

NAME (Last, First): _____ LAST 4: _____

GENDER: ☐ M ☐ F DATE (DD-MMM-YY): _____ TIME: _____

SERVICE: _____ UNIT: _____ ALLERGIES: _____

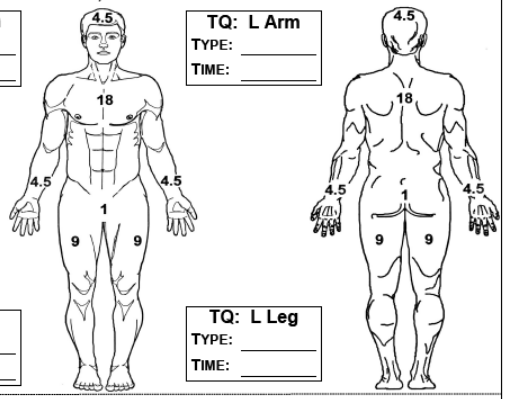
Mechanism of Injury: (X all that apply)

☐ Artillery ☐ Blunt ☐ Burn ☐ Fall ☐ Grenade ☐ GSW ☐ IED
☐ Landmine ☐ MVC ☐ RPG ☐ Other: _____

Injury: (Mark injuries with an X)

TQ: R Arm
TYPE: _____
TIME: _____

TQ: L Arm
TYPE: _____
TIME: _____



TQ: R Leg
TYPE: _____
TIME: _____

TQ: L Leg
TYPE: _____
TIME: _____

Signs & Symptoms: (Fill in the blank)

Time				
Pulse (Rate & Location)				
Blood Pressure	/	/	/	/
Respiratory Rate				
Pulse Ox % O2 Sat				
AVPU				
Pain Scale (0-10)				

DD Form 1380, JUN 2014 TCCC CARD

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

Treatments: (X all that apply, and fill in the blank) *Type*

C: TQ- ☐ Extremity ☐ Junctional ☐ Truncal _____
Dressing- ☐ Hemostatic ☐ Pressure ☐ Other _____

A: ☐ Intact ☐ NPA ☐ CRIC ☐ ET-Tube ☐ SGA _____

B: ☐ O2 ☐ Needle-D ☐ Chest-Tube ☐ Chest-Seal _____

C:

	Name	*Volume*	*Route*	*Time*
Fluid				
Blood Product				

MEDS:

	Name	*Dose*	*Route*	*Time*
Analgesic (e.g., Ketamine, Fentanyl, Morphine)				
Antibiotic (e.g., Moxifloxacin, Ertapenem)				
Other (e.g., TXA)				

OTHER: ☐ Combat-Pill-Pack ☐ Eye-Shield (☐ R ☐ L) ☐ Splint
☐ Hypothermia-Prevention Type: _____

NOTES:

FIRST RESPONDER
NAME (Last, First): _____ LAST 4: _____

DD Form 1380, JUN 2014 (Back) TCCC CARD

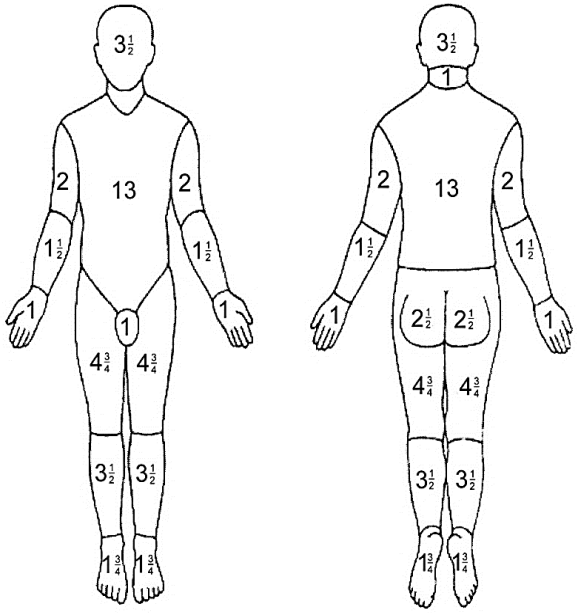
APPENDIX B: PROLONGED FIELD CARE FLOWSHEET –PAGE 1 (Newest Version Available at Prolongedfieldcare.org)

Day																										D	**Checklist** ✓
Hour																										H	Reassess Tx
Minute																										M	Expose
																											Detailed Exam
	200																									200	Send MIST Report
	190																									190	Monitors
	180																									180	2nd IV/IO
	170																									170	GCS/Neuro/MACE
	160																									160	Analgesia
	150																									150	Sedation
BP	140																									140	NG / OG
Systolic ˅	130																									130	Upgrade Airway
Diastolic ^	120																									120	Post Cric Checklist
	110																									110	Vent w/ PEEP
Temp X	100																									100	Hypothermia Tx
	95																									95	Recalc TBSA & Fluids
SPO2 ◊	90																									90	Ultrasound eFast
	85																									85	Fluid Challenge
	80																									80	1st TXA dose (<3hrs)
Pulse ●	75																									75	Blood Type Card
	70																									70	FWB Transfusion
MAP Δ	65																									65	Convert TQ <4hrs
	60																									60	Foley/Bladder Tap
	55																									55	Adjust Vent Settings
	50																									50	UA Dipstick
	45																									45	Clear C-Spine
ETCO2 ▪	40																									40	Position Pad Patient
	35																									35	Peripheral Pulses
	30																									30	Compartment Syndrome
	25																									25	Escharotomy
	20																									20	Reduce / Splint Fx
Respirations ○	15																									15	DVT Prophylaxis
	10																									10	Antibiotic War Wound Tx
	5																									5	Tetanus
	0																									0	Teleconsult
	No read																									No read	Labs
Output																											X-Ray / Imaging
Fluid Input																											PreOp Eval
Pain scale/RASS																											Debridement
AVPU/Neuro/MACE																											
Eye response	**4**																										Nursing Care Reminders ✓
Oral Response	**5**																										Vitals q1h
Motor Response	**6**																										Flush Saline Locks
GCS Total	**15**																										Suction ET Tube
Drug/Intervention:	Dose:																										Reposition q2hrs (30˚ Each side)
																											Change Blood Tube q4hrs
Drug/Intervention:	Dose:																										Oral Care / Hygeine q4hrs
																											Foley Care q4hrs
Drug/Intervention:	Dose:																										Sponge Bath q8hrs
																											Change IV Bag q24hrs
Drug/Intervention:	Dose:																										Change Foley Cath q72hrs
																											Change IV Lines q72hrs
Drug/Intervention:	Dose:																										Change HME q72hrs
Drug/Intervention:	Dose:																										
Drug/Intervention:	Dose:																										
Drug/Intervention:	Dose																										

PROLONGED FIELD CARE FLOWSHEET PAGE 2

Name:	Date:	Time:	Blood type:	EVAC Category:

S:	
A:	
M:	
P:	
L:	
E:	



MOI

	Injuries / illness / problems	Treatment plan
1		
2		
3		
4		
5		
6		

TQ 1 time on:	TQ 2 time on:	TQ 3 time on:	TQ 4 time on:	TXA Dose 1 on:
TQ 1 Converted:	TQ 2 Converted:	TQ 3 Converted:	TQ 4 Converted:	TXA Dose 2 on:

Notes:

Telemedicine Call Script

This is _____, an_____ (Job Position)
I have a patient with _____ who I think has_____ and I need _____ Chief Complaint_____ Brief History_____
Vitals HR_____ RR_____ BP_____ Temp_____
Pulse Ox_____ UOP _____ AVPU _____
Exam Findings
_____
_____

Recommendations
_____
_____
_____

Fluids/Meds_____
Interventions_____
Red Flags_____

APPENDIX C: VIRTUAL CRITICAL CARE CONSULTATION GUIDE

1. Before calling, E-mail image of the casualty (wounds, environment, etc.), "capabilities" (back of page), & vital signs trends to _____
2. If call not answered: a) call next number on PACE or call back in 5 – 10 min.
3. If unable to provide information due to operational security, state so.

P:
A:
C:
E:

This is _____ I am a (job/ position) _____
My best contact info is: _____
YOUR best contact info is (Consultant's number): _____Alternate e-mail: _____

****** PAUSE POINT to CONFIRM CONTACT INFO******

I have a _____ year–old _____(sex) _____ (active duty/foreign national/OGA,etc.), who has the following:
Mechanism of Injury or known diagnosis(es) that occurred in (location)
The injury/start of care occurred *hours ago*. Anticipated *evacuation time* is (range)
Injuries/Problems/**S**ymptoms:
Treatments:
He/she is currently (circle) stable/ unstable, getting better/ getting worse/ getting worse rapidly
Known Medication Allergies/Past medical/Surgical history is:
I need help with (*be specific if possible, i.e. "I need help reading this ECG," or "I need help stabilizing this patient," etc.)*
Other Consultants have recommended:

****** PAUSE POINT for Remote Consultant to ask clarification questions ******

VITALS (*current* & *trend* as of): HR	BP	RR	SpO2	$EtCO_2$	Temp…….	
UOP(ml/hr)	over	(# hours)	Mental Status (GCS/ AVPU)			
EXAM: Neuro		Ext/ MSK				
Heart		Pulses				
Lungs		Skin/ Wounds				
Abd						
LABS: ABG:	Lactate:	Other:				

****** PAUSE POINT for Remote Consultant to ask clarification questions *****

VIRTUAL CRITICAL CARE CONSULTATION GUIDE PAGE 2

Plans/Recommendations		
PRIORITY	**SYSTEM/PROBLEM**	**RECOMMENDATION**
	Neuro or problem #1	
	CV or problem #2	
	Pulm or problem #3	
	GI or problem #4	
	Renal or problem #5	
	Endocrine or problem #6	
	MSK/ Wound or problem #7	
	Tubes, lines, drains or problem #8	
	Prophylaxis/prevention or prob#9	
	Other	

TO-DO/ FOLLOW-UP/TO-STOP	**NOTES**
1.	
2.	
3.	
4.	
5.	
6.	

****** PAUSE POINT, for Medic/Local Caregiver to ask clarification questions/READBACK******

Available "kit" (supplies, equipment, medications) !! IF POSSIBLE PHOTOGRAPH AND SEND VIA EMAIL BEFORE CALLING !!

IV access: IV Central line IO (location) Other:_____

Monitor: Propaq Tempus Foley Graduated urinal PulseOx only Exam Only
Other:_____

Commo: Tempus i2i ID: _____THIAB:_____SAT#_____Local Cell#_____
Web VTC Address_____
Other (e.g. "FaceTime, VSee, Skype, etc.):_____

IV Fluids: Plasma-Lyte LR Normal Saline 3% saline Other:_____

Colloids: Hetastarch Albumin Other:_____

Blood products: Whole blood PRBC Plasma FDP Platelets Other:_____

Medications: Antibiotics: name/route/dose_____
Morphine IV/ PO Other opioid (name/ IV/ PO): _____
Fentanyl IV/ PO (pop) Ketamine
Midazolam Diazepam (IV/ PO)
TXA Other(s): _____

Airway supplies: ETT Cric kit LMA Ventilator BVM O2 Suction

Misc:

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Documentation Requirements for Combat Casualty Care (CPG ID: 11)

This CPG stresses the need for complete and accurate trauma documentation of an event, including evacuation on all trauma patients from point of injury to Role 2/3.

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Supersedes CPG: Use of Electronic Clinical Documentation in the CENTCOM AOR, 5 Jun 2012

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BACKGROUND

Trauma documentation within the military trauma system supports optimal patient care and performance improvement (PI). Documentation has continuously increased since the Joint Theater Trauma Registry (JTTR), now known as the DoD Trauma Registry (DoDTR), was initiated in 2004. DoDTR data acquisition and processing has improved greatly, due in part to standardization of the Resuscitation Record, Tactical Combat Casualty Card (TCCC), and Tactical Evacuation (TACEVAC) Patient Care Record (PCR) as well as standardized prehospital and en route care after action reports (AARs) and PI reviews. The dedicated efforts by Service, Combatant Command, and JTS personnel to capture these documents following patient care promotes inclusion within the medical record and transfer to the DoDTR. During massive casualty events, documentation reduces chaos and improves patient tracking.

Accurate documentation improves:

- Trauma readiness
- Treatments
- Outcomes
- Standard of care development
- The evaluation of rescue systems
- Casualty response processes
- Adherence to approved treatment guidelines

It is critical that all levels of the trauma system, including point of injury, en route, austere and facility-based roles of care, ensure that their casualty documentation, after action reports, and PI forms reach the JTS for incorporation into the DoDTR.

Combat casualty care documentation incorporates information from numerous sources such as nursing flow sheets, monitors, Medical Evacuation (MEDEVAC) patient care records, point of care laboratory devices, and anesthesia records. Documentation of history, physical examination, interventions and decision-making not only optimizes ongoing care of the casualty, but also contributes to improved care of future casualties when incorporated into the DoDTR. For prehospital providers and small teams who operate in a kinetic and austere setting, it may not be possible to document and provide care simultaneously, and providing optimal care always takes priority. In such cases, completion of the documentation and AAR as soon as possible after the event with transmission to JTS, preferably within 72 hours of injury, is necessary and meets the intent of this CPG.

Documentation of trauma care provided to all patients treated within the military system is relevant, and all categories of patients treated are incorporated into the DoDTR. It is critical that all roles of care utilize the same name for an individual casualty according to the theater standard pseudo name policy to ensure quality data. This requires communication and follow up, particularly for reports submitted after evacuation from that role of care. While technology is being implemented to facilitate electronic documentation by the initial roles of care, much of the initial trauma documentation is still hand-written and must be scanned in to the Theater Medical Data Store (TMDS) order to incorporate into the records. As there is no global solution to this challenge, each treating location must identify a means to transfer hand-written records to a location where they can be scanned.

PATIENT CARE DOCUMENTATION GUIDELINES

PREHOSPITAL DOCUMENTATION

The DD 1380, TCCC Card, is initiated by point of injury non-medical or medical personnel once all major life threats have been addressed in accordance with TCCC guidelines. Each Service member should carry a DD 1380 with their personal identifiers pre-positioned and stored within their first aid kit.

The purpose of the DD 1380 is to provide prehospital providers a standardized document to record all TCCC interventions administered at the point of injury and facilitate handoff to the next role of care. It should accompany the casualty during initial evacuation and be accounted for upon arrival at the first surgery capability. The TCCC card will be scanned and uploaded into TMDS utilizing the casualty name established by the first surgical team.

TCCC AAR documents should be submitted for each casualty to the JTS via the AAR submission email link on the JTS Forms and After Action Report Submission web page within 72 hours post injury or as soon as possible after mission completion. AARs must be submitted using the actual name or pseudo name for all patients subsequently treated by surgical teams; this requires communication and follow up between the prehospital and surgical teams. A secure email option is provided for convenience, however AARs submitted to the DoDTR should include only content up to the "For Official Use Only" level. The prehospital PI form should be used to review care and documentation and should be completed by the Unit Medical Officer or the Senior Enlisted Medical Advisor and submitted along with the AAR using the previous JTS web link. Units requesting a unit-specific PI report can contact JTS at dha.jbsa.healthcare-ops.list.jts-prehospital@health.mil (unit must be identified on the AARs or a patient log provided).

When prehospital care transitions to PFC, documentation should transition from the TCCC card to the Prolonged Field Care (PFC) Worksheet. As a follow-on to the TCCC card, the PFC Worksheet is used to document trends over time and is the most useful tool to recognize important clinical changes in complex casualties such as decompensation, response to resuscitation, development of complications, effectiveness of medications, etc.

TRANSPORT DOCUMENTATION

The TACEVAC Evacuation Patient Care Record (DA 4700) and AAR should be initiated on all patients transported via ground or rotary-wing platform. This form may be initiated during transport, but is ideally suited to be completed electronically after mission completion. Forms should be reviewed by local medical directors to aid in unit level quality assurance efforts. These forms should be completed within 72 hours of a patient care event, and may be completed digitally or by hand. (This form is not intended to supersede the AF 3899 during patient transport by Air Force air evacuation assets).

ROLE 2 & ROLE 3 DOCUMENTATION

A Resuscitation Record (DD 3019) and any required supplemental documentation (JTS Burn Flow Sheet, C-Spine Clearance Form, etc.) should be initiated on ALL patients anticipated to be admitted in a Role 2 setting or higher role of care (including those patients who are transferred for admission to a host nation facility). This includes patients with battle/non-battle injury who are coalition forces, local nationals, contractors, and civilians. *It is the intent of this guideline that the broadest definition of* ***trauma*** *be used.* This should include the majority of patients with single or multi-system injury seen in the emergency department who may require admission or who are admitted directly to the hospital, and is to be used as the primary method of initial documentation.

In situations when there are not enough team members to allocate one individual to documentation, such as during mass casualty events or austere surgical team treatments, the MASCAL/Austere Team Record may be utilized (DD Form # pending).

The Resuscitation Record (DD 3019) should be completed on all patients evaluated and admitted within the first 72 hours following injury, including but not limited to the following injury causes:

- Building Collapse
- Bullet/Gunshot Wound/Firearm
- Burn
- Explosively Formed Projectile/Penetrator
- Fall
- Fire/Flame
- Improvised Explosive Device
- Inhalation Injury
- Mine
- Mortar/Rocket/Artillery Shell
- Multi-Frag
- Motor Vehicle Crash
- Sports
- Unexploded Ordnance
- All trauma admissions to any/all Role 2 or 3 facilities in the continuum

All care delivered by each resuscitation and surgical capability will be documented for that role of care on the appropriate record and signed by the physician (preferably), nurse, or team member documenting before transport to next role of care. In situations where evacuation occurs before documentation can be completed, the record should be completed as soon as possible and transmitted electronically to the next role of care as well as to JTS. It is important that all documents are annotated with provider names with both a time and date of injury as well as arrival to surgical capability in order to ensure timeline accuracy within the registry. If time of injury is an estimate, note that in the documentation.

THEATER MEDICAL DATA STORE & TRAUMA LOGS

The TMDS provides web-based access to Service member medical information entered at deployed medical treatment facilities using AHLTA-Theater (Armed Forces Health Longitudinal Technology Application), Shipboard Automated Medical System (SAMS), Global Expeditionary Medical System (GEMS), Caché TC2, and TRANSCOM Regulating and Command & Control Evacuation System (TRAC2ES). Additionally, all documentation saved as PDF files, including scanned documents, can be uploaded to TMDS as PDF files.

Authorized individuals may request a TMDS user account by accessing the website https://tmds.tmip.osd.mil, connecting to "need access" and completing the registration form; account requests must be reviewed and validated before user accounts are created. User accounts are usually validated and activated within 48 hours of the request. TMDS is accessible from a government computer with .mil account.

Records entered in the deployed electronic health records must utilize an appropriate ICD-10 diagnosis code to ensure the records are identified as trauma records (do not utilize the generic 9999 code). In order to ensure all TMDS trauma records are identified by JTS, each team must record a log of trauma patients treated and submit the log to JTS weekly. The log should include the following for each patient:

- Name/pseudo name; SSN/PSSN
- Patient Category; Injury Date; Transferred From (prior to arrival)
- Arrival Date; Discharge Date
- Discharge Status

- Discharge/Transfer To
- Record uploaded in TMDS/Sent to JTS? (YES/NO)

In the event that no trauma patients were treated the previous week, a 0-patient report should be submitted. Submit to: dha.jbsa.healthcare-ops.list.jts-trauma-log@health.mil

Services should develop and implement doctrine, tactics, training, security procedures, and logistical support that ensures combat casualty care documentation is uploaded into TMDS and transmitted to the JTS.

DOD & JTS FORMS

Fillable PDF forms are available on the ***JTS Forms and After Action Report Submission*** website. Forms can be downloaded individually or together in the forms ZIP file at https://jts.health.mil/index.cfm/documents/forms_after_action

PRIMARY REQUIRED FORMS

- Tactical Combat Casualty Care Card (DD 1380)
- Point of Injury Tactical Combat Casualty Care After Action Report
- Tactical Evacuation After Action Report & Patient Care Record and Instructions
- Resuscitation Record (DD 3019) and Instructions
- Mass Casualty (MASCAL)/Austere Trauma Team Resuscitation Record and Instructions

PROLONGED FIELD CARE

- Prolonged Field Care Casualty Card - Worksheet
- Excel version of Prolonged Field Care Card - Worksheet

BLOOD TRANSFUSION FORMS

- Vampire Program CCOP-01: Urgent Resuscitation Using Blood Products During Tactical Evacuation From Point Of Injury
- Urgent Resuscitation Using Blood Products During Tactical Evac - Appendix A
- Infectious Disease Testing for Blood Donation (ASBP 145)
- Eldon Card ABO/Rh Typing Record (ASBP 147)
- Pre-screen Whole Blood Sample Shipping Manifest (ASBP 148)
- Emergency Release Letter of Understanding (tested) (ASBP 150A)
- Emergency Release Letter of Understanding (untested) (ASBP 150B)
- Whole Blood Transfusion Checklist (ASBP 151)
- Blood or Blood Component Transfusion Record ASBP (SF 518)
- Emergency Whole Blood Donation Record (ASBP 572)

- AABB Medications Deferral List
- DHQ Medication Deferral List

BURN CPG FORMS

- JTS Burn Resuscitation Worksheet
- JTS Burn Resuscitation Flow Chart
- Lund Browder Burn Estimate Diagram (Adult & Pediatric)
- JTS Burn CPG Physician's Order Form

REBOA FORM

- Aortic Occlusion (AO) Procedure Notes: REBOA or Resuscitative Thoracotomy

SPINAL INJURY – CERVICAL & THORACOLUMBAR FORMS

- Cervical Spine Clearance Status Note
- ASIA Worksheet for Spinal Cord Injury
- Combat Neuro Exam Worksheet

BRAIN INJURY FORM

- Military Acute Concussion Evaluation 2 (MACE 2) Form, 2018

MILITARY WORKING DOG FORMS

- Canine Tactical Combat Casualty Card (DD 3073) and Instructions
- Canine Treatment and Resuscitation Record (DD 3074) and Instructions

All forms can be downloaded from the JTS website:

JTS Forms and AARs: https://jts.health.mil/index.cfm/documents/forms_after_action

EXPECTATIONS : FORM COMPLETION

- All individuals providing prehospital trauma care will complete a DD 1380 TCCC Card and ensure it is passed to providers at the next role of care for all casualties treated. The TCCC AAR form will be completed by the point of injury provider and submitted within 72 hours after mission completion via the JTS AAR Report Submission site at: https://jts.health.mil/index.cfm/documents/forms_after_action. The Prehospital PI Form will be completed by the unit senior medic or Command Surgeon and submitted to the JTS TCCC/POI AAR email submission link.
- All individuals providing en route care during MEDEVAC or Casualty evacuation (CASEVAC) by air or ground will complete a TACEVAC AAR & PCR or Service equivalent form and submit within 72 hours after mission completion to the JTS AAR Report Submission site at: https://jts.health.mil/index.cfm/documents/forms_after_action. The TACEVAC Form will be

completed by the unit senior medic or Command Surgeon and submitted via the JTS TACEVAC AAR & PCR submission email. .

- Air Evacuation and Critical Care Air Transport teams will use appropriate Air Force documentation forms (e.g., AF 3899 series) and submit forms to JTS within 7 days after mission completion. dha.jbsa.healthcare-ops.list.jts-trauma-registry@health.mil.
- All Role 2 and Role 3 surgical teams and all austere resuscitative and surgical teams will complete the DD 3019 Resuscitation Record or MASCAL/Austere Trauma Team Record (whichever is most appropriate) for all trauma patients anticipated to be admitted and ensure the document is uploaded into TMDS within 72 hours of injury.
  - The DD 3019 Resuscitation Record is considered the primary form and should be used preferentially for trauma evaluations.
  - The MASCAL form should be used in austere trauma scenarios and during mass casualty events when an individual cannot be dedicated to documentation. The MASCAL form is not a substitution for the DD 3019 Resuscitation Record.

***NOTE**: Any documentation related to patient care should be uploaded to TMDS. **Documentation of trauma care does NOT require a DD/DA/AF form number to be uploaded to the medical record and should never be discarded.** Examples may include: photos of the injury and surgical procedures; photos of medical documentation written directly on the skin or dressings. All documents detailed in this CPG should be included, as well as any other medical form used that is not listed within the CPG (i.e. medication administration record, anesthesia record, SF 600).*

PI MONITORING

POPULATION OF INTEREST

All trauma patients evaluated within 72 hours of injury and admitted to Role 2 or Role 3.

INTENT (EXPECTED OUTCOMES)

1. All trauma patients who receive prehospital care have a DD 1380 TCCC card completed in patient's record and uploaded in TMDS.
2. All patients evacuated by MEDEVAC or CASEVAC air or ground have a DA 4700 form completed in patient's record and uploaded in TMDS.
3. Trauma log is received at least monthly from all Role 2 and Role 3 locations.
4. Resuscitation Record is completed at each surgical role of care on all trauma patients who present within the first 72 hours following injury and are admitted.
5. Resuscitation Record Part 1 has time of injury and time of arrival documented.
6. Resuscitation Record has complete and accurate documentation of patient identification utilizing theater trauma naming convention policy.
7. Resuscitation Record Part 2 has complete history and physical documented.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients who have a DD 1380 TCCC card and/or TCCC AAR uploaded in TMDS or submitted to JTS.
2. Number and percentage of patients evacuated by MEDEVAC or CASEVAC air or ground who have a DA 4700 form uploaded in TMDS or submitted to JTS.
3. Number and percentage of Role 2s that submit a trauma log to JTS each month.
4. Number and percentage of patients of in the population of interest with Resuscitation Record uploaded into TMDS or received by JTS within 72 hours of injury.
5. Number and percentage of patients in population of interest with time of injury and time of arrival documented in Resuscitation Record Part 1.
6. Number and percentage of patients in population of interest with complete and accurate patient identification documented according to theater trauma naming convention policy.
7. Number and percentage of patients in population of interest with complete history and physical documented.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed biannually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

1. It is the trauma team leader's responsibility to ensure the Resuscitation Record Part 2, Physician H&P is complete at Role 2 and Role 3.
2. It is the responsibility of the nurse assigned to the trauma bay/patient to ensure the Resuscitation Record Part 1, Nursing Flow Sheet is completed at Role 3.
3. A member of the trauma team who is receiving report (Critical Care Air Transport, MEDEVAC, ground ambulance) should request a copy of the transport run-sheet and ensure it is included in the patient's record. All times on the Resuscitation Record should be local 24-hour military format (hhmm).

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Drowning Management (CPG ID:64)

This guide helps first responders, prehospital emergency medical service personnel, and medical department personnel evaluate, diagnose and manage common in-water pathologies.

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GOALS

This CPG provides an overview of drowning and associated conditions based on the best available current medical evidence. It should be used as a standardized framework to guide first responders, prehospital emergency medical service personnel, and medical department personnel in evaluating, diagnosing, and managing common in-water pathologies.

EPIDEMIOLOGY OF DROWNING

- Highly skilled swimmers and aquatically adaptable service members such as U.S. Navy Divers, EOD technicians, and SEALs die every year from drowning.
- Responsible for > 500,000 civilian deaths/year worldwide (thought to be greatly underestimated) boating accidents and natural disasters (floods, tsunami, etc.).
- Leading cause of death worldwide in boys aged 5-14 (2nd most common cause in children, 3rd in most common cause young adults).
- Alcohol is involved in the majority of drowning accidents.
- Leading cause of deaths or contributing factor among scuba divers (100-150/year). In many cases it is difficult to determine if drowning is the primary cause or secondary to an in water emergency such as (1) loss of buoyancy control; (2) entanglement; (3) air supply exhaustion; or (4) medical condition (MI/hypoglycemia/seizure).[1-3]

PATHOPHYSIOLOGY OF DROWNING

Immersion in water, panic, overexertion/exhaustion, inability to cope with rough water, or effects of hypo/hyperthermia lead to:[1-5]

- Airway below the surface → breath hold breakpoint (inability to resist urge to breath) → hypoventilation → hypercapnia, respiratory acidosis, and hypoxemia → loss of consciousness (LOC) → passive flooding of the airway → cardiopulmonary arrest
- Cold water immersion – water conducts heat 25x faster than air resulting in a rapid drop in core temperature.
  - Shock to system causing sudden gasp for air, tachypnea, vasoconstriction, tachycardia.
  - May progress to arrhythmias, altered mental status, diminished strength and coordination.

PREVENTION

Respect the power of moving water and debilitating effects of cold water on the body.[1,6,7] Fast moving water should be treated with the same respect as a 1,000 foot cliff.

- Wear a personal flotation device (PFD) and have a PFD available for every person.[1,6,8]
  - Huddle - if in a group, everyone face inward and huddle with arms interlocked.
  - Get as much of body out of the water as possible (climb onto submerged boat), wind removes less heat than water.[1,6,9]

- Learn to swim, tread water, or float (not a substitute for PFD) and always swim with others.
- Have a well-developed safety and rescue plan that is exercised and practiced routinely.[1,6]
- Average vehicle takes 30 seconds to 2 minutes to sink.
- Once even partially submerged, windows and doors become impossible to open or kick out (unlike what is commonly seen in the moves). Do not wait, act immediately to escape.
- Vehicle escape procedure:
    1. Unfasten adult restraints.
    2. Open windows.
    3. Unfasten child restraints.
    4. Children exit youngest to oldest (if multiple children have oldest go first and hold onto vehicle and pass younger children out by the adult still inside the vehicle).[1,6,7,10]

PHASES OF TREATMENT[1,6]

1. Rescue and In-water Resuscitation
2. Initial Resuscitation on Land
3. Advanced Prehospital Care
4. ER/ICU Care

COLD WATER IMMERSION SELF AID

Sudden immersion in cold water (< 91.4°F/33 °C) causes panic and reflexive gasp for air and rapid breathing making: [1,2,5-7,9,11,12]

- Inhalation/aspiration of water more likely.
- Core temperature drop causing arrhythmias, confusion, incapacitation (diminished strength and coordination) increasing the chance of drowning.
- Water conduct heat away from the body 25 times faster than air leading to immersion hypothermia – impaired meaningful movement usually precedes.[1,6,11]
- 1 min/10 min/ 1 hour /2 hour Rule 1,3 – steps to survival:
    1. Control your breathing and survive the first minute.
    2. You have 10 minutes to move thoughtfully and carefully before you will become incapacitated by cold.
    3. You have 1 hour before you will become unresponsive due to hypothermia.
    4. You have 2 hours before your heart stops beating.
    5. Assuming you have a floatation device, while awaiting rescue assume HELP (heat escape lessening posture) by bring your knees to your chest and cross your arms over them or Huddle position by grouping together. [1,6,7,9,17]

Figure 1. Ice rescue training

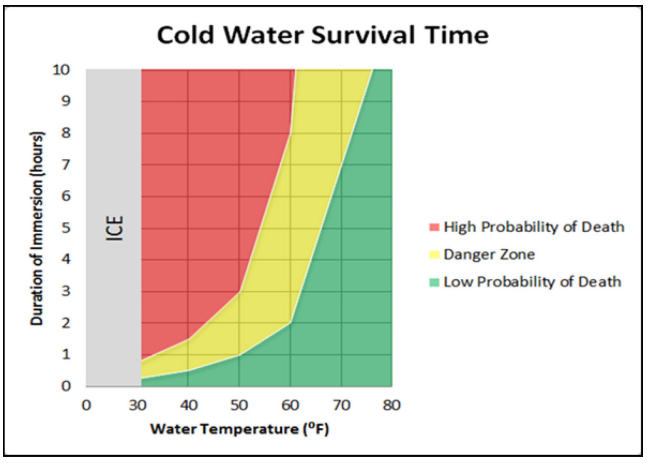
Graphic created by LT Parenteau from USCG video[13] available at https://www.youtube.com/watch?v=UzHC8hNLp34

Table 1. Expected Survival Time in Cold Water

Water Temperature	Time to Exhaustion or Unconsciousness	Expected Survival Time
> 80° F (27° C)	Indefinite	Indefinite
70–80° F (21–27° C)	3–12 hours	3 hours – indefinitely
60–70° F (16–21° C)	2–7 hours	2–40 hours
50–60° F (10–16° C)	1–2 hours	1–6 hours
40–50° F (4–10° C)	30–60 minutes	1–3 hours
32.5–40° F (0–4° C)	15–30 minutes	30–90 minutes
<32° F (<0° C)	Under 15 minutes	Under 15–45 minutes

Based off of table available here: http://www.ussartf.org

Figure 2. Cold Water Survival Time



Graph created by LT Parenteau based on data in table.9

RESCUE AND IN-WATER RESUSCITATION

1. Identify and locate the victim (ask if there are more than one).[1,6]
   - Often seen motionless, sinking slightly below the surface.
   - Diving into the water and never surfacing.
2. Goals: initially type of water does NOT matter (salt, fresh, clean, dirty).[1,6]
   - Alert advanced life support as soon as possible.
   - Accurately record environmental conditions including time of submersion, type and temperature of water and air, scuba diver (depth, time at depth, type of dive rig).
   - Rescuer safety is a priority (avoids more casualties). Rescuers must balance personal safety and removing the drowning victims from the water by the fastest means available by using methods like reach, throw, row, tow, go:[1,6,14]
     1) Reach with an object from the safety of the shore or ship.
     2) Throw an object like a rope or flotation devices (this may help the victim stay afloat or the search and rescue team locate the victim.)
     3) Row (or paddle) a smaller craft to the victim if they are too far from shore to reach or have a floatation device thrown. The rescuer should ideally stay out of the water.
     4) Tow them into shore or away from danger in the water (i.e. swift water rescue).
     5) Go into the water (as a last resort) to rescue the victim (highest risk to rescuer).
   - Additional risks to the rescuer include open water, swift water, or ice.
   - In water rescue breaths should only be done when rapid extraction is NOT feasible. In water chest compressions are NOT effective.[1,3,15,16]
   - Cervical spine injury in drowning victims is low (0.009%). Unnecessary cervical spine immobilization can impede delay delivery of rescue breaths and adequate opening of the airway. Routine stabilization of the cervical spine in the absence of circumstances that suggest a spinal injury (diving, boat accident, and fall from height) is not recommended. If suspected, protect cervical spine by assuming neck injury (use jaw thrust to open the airway).[1, 4, 6,7,12]
   - Handle patients rescued from cold water gently as possible as rough handling of hypothermic patients may trigger a lethal arrhythmia. Priority remains oxygenation, ventilation, and restoring circulation.

Figure 3. HELP posture

Pictures modified by LT Parenteau [8,17]

INITIAL RESUSCITATION ON LAND [1,3,6,7,12]

1. Call for help and encourage patient to move away from danger. [15,16]
2. Place the patient parallel to the shoreline so that the head and feet are at the same level.
3. CPR: Airway, Breathing, Circulation (not CAB due to respiratory impact of drowning)
    - If unconscious and not breathing, begin with 5 rescue breaths (ABC rather than CAB), then continue with 30:2 (compressions: rescue breaths). Five breaths are used initially because water in the airways can interfere with effective alveolar expansion initially. A drowning patient with only respiratory arrest usually responds after a few rescue breaths.
    - Cardiac arrest from drowning is due primarily to lack of oxygen.
4. Ventilation support with available tools (oxygen, bag valve mask (BVM), etc.)
5. Prepare for vomiting: 65% of victims requiring rescue breathing vomit; 88% of those receiving chest compressions will vomit.

WHO TO EVALUATE [1,3,6]

- Anyone who required resuscitation : All victims of drowning who require any form of resuscitation (including rescue breathing alone) should be transported to the hospital for evaluation and monitoring, even if they appear to be alert and demonstrate effective cardiorespiratory function at the scene
- Anyone unresponsive in the water
- Anyone exhibiting distress (shortness of breath, persistent cough, anxiety, tachypnea, syncope, foam in the mouth or nose, change in vital signs, abnormal breath sounds, or hypotension).

ADVANCED PREHOSPITAL CARE

Secure airway → improve oxygenation → stabilize circulation → gastric decompression → thermal insulation.[1,6]

Maintain airway, begin CPR if necessary.

1. Attempt resuscitation unless clear signs of death (dismemberment, rigor mortis, decomposition, decapitation, etc.) or operational requirement.[4]
    - Rare case reports surviving prolonged submersion (especially in ice water).
    - Pulse may be difficult to identify due to hypothermia or hypotension. Do not use as sole indicator of death.
2. Avoid head down positioning or abdominal thrusts as they delay ventilation and increase vomiting, which increases the risk of aspiration and mortality. Heimlich maneuver NO LONGER recommended for drowning.[7,14,18]
3. If unconscious but breathing, stabilize airway by putting patient in recovery (lateral recumbent) position as vomiting is common and can lead to aspiration.[1,3]
4. If unconscious and not breathing, begin with 5 rescue breaths (ABC rather than CAB), then continue with 30:2 (compressions: rescue breaths). Five breaths are used initially because water in the airways can interfere with effective alveolar expansion initially. A drowning patient with only respiratory arrest usually responds after a few rescue breaths.[3,18,19]
5. If no response, assume cardiac arrest.
6. Finger sweep if foreign body (sand, seaweed, etc.).

100% O2 at 15 liters/min as soon as possible and until discontinued by medical officer.[1,3]

1. Victim may be able to compensate for drowning insult by ↑ respiratory rate.
2. Consider early intubation/mechanical ventilation/ Positive end-expiratory pressure (PEEP) or Bilevel Positive Airway Pressure (BiPAP). Anticipate patient may vomit, so need to monitor for this and consider rapid sequence intubation (RSI) if available to minimize risk of aspiration
3. Goal arterial oxygen saturation 92-96%: Place pulse oximeter on ear lobe or forehead for more accurate readings due to vasoconstriction.[20,21]

CARDIAC INTERVENTIONS

- Most common dysrhythmias are asystole and pulseless electrical activity (PEA).[1,3,4]
- Many ACLS interventions are ineffective with low core body temperatures, including pacing, atropine, lidocaine and defibrillation. Antiarrhythmics should be withheld for core temperatures of < 30 °C (86 °F), with emphasis placed on chest compressions and ventilations to maintain perfusion.[18]
- Manage arrhythmia per ACLS protocols.

- If history of unobserved LOC think C-spine precautions, intoxication, arterial gas embolism (AGE) - if history and circumstances suggest it (e.g., scuba diver surfacing unconscious or with neuro complaint)[2] If AGE is suspected, begin notification of hyperbaric chamber team.
- Consider gastric decompression as many drowning patients swallow water prior to inhaling and between 60-80% will vomit at some point during recovery or resuscitation.
- Keep the victim warm (use core temperature instead of infrared devices.

NOTE: *A low range refrigerator thermometer may be necessary). Stabilize body temperature - dry and insulate the patient to prevent heat loss.* [1,20,21]

- **Mild hypothermia**: > 34°C (>93.2°F): passive rewarming (i.e. warm blankets and environment).
  - Moderate hypothermia:30-34°C (86-93.2°F): active external rewarming will be required when available (i.e. heating blankets, radiant heat, forced hot air, warmed IV fluids at 43°C (109°F) , warm water packs).
  - Severe hypothermia: < 30°C (86°F): active internal rewarming will be required when available (peritoneal lavage, esophageal rewarming tubes, cardiopulmonary bypass, extracorporeal circulation); consider extracorporeal membrane oxygenation.
  - Withhold ACLS medications until temperature >30°C (86°F).[14]
  - Glucose – maintain between 80-140 mg/dL for ventilated patients.
- **IV fluids**: Obtain access, place Foley when appropriate to monitor output.[1,3]
  1. If oxygenation does not correct hypotension, give IV crystalloid.
  2. Continue monitoring vital signs as drowning patients are often mildly intravascularly dehydrated. This combined with mechanical ventilation using PEEP can increase intrathoracic pressure and decrease central venous return.
  3. Provide sufficient resuscitation to stabilize vital signs as this will also allow inotropic and mechanical ventilation to improve tissue oxygenation.
  4. Careful fluid management is key as drowning victims are at high risk for pulmonary edema.
  5. For hypothermic patients, continue monitoring temperature and use warmed IV fluids at 43°C (109°F) to rewarm.[12]
- **Assess patient history & physical, vital signs**, determine Glasgow coma scale.
  - Lung injury may take up to 6 hours to present and may not be immediately present.
  - Monitor for wet lung sounds, productive cough, rapid shallow breaths, substernal burning, irregular/slow heart rate, altered consciousness.
- **Transport**: Evacuate if victim required resuscitation, was unresponsive in the water, or has dyspnea or other respiratory symptoms.
  - Full neurological recovery has occurred occasionally after prolonged submersion in both icy and warm water.

- Continue resuscitation and transported to higher level of care unless there are obvious signs of death.

- **Brain resuscitation**: The following have not shown benefit: No role for mannitol, diuretics, hypertonic saline (unless hyponatremic), mechanical hyperventilation, barbiturate coma, intracranial pressure monitoring.
- **Terminating resuscitation efforts in the field.**[1,7]
  - After 1 hour submerged in water rescue should transition to body recovery with appropriate medical examiner evaluation for foul play (longest submerged survival 66 min).
  - Resuscitation may be stopped after 30 minutes of CPR without return of spontaneous circulation if patient is not hypothermic.
  - If there is any uncertainty, continue resuscitation until patient is rewarmed to 30-34 °C/86-93 °F, then continue CPR until asystole has persisted for >20 minutes.
  - Lowest recorded survival with neurologic recovery was core temp of 56.6°F/13.7 °C. However, only 17% of patients who require resuscitation in the ED will have functional recovery with minimal neurologic impairment and the ability to independently perform activities of daily living. If no cardiac activity once re-warmed, stop.
  - Increased duration of submersion increases risk of death or severe neurologic impairment.[3]
    - 0-5 min – 10%
    - 6-10 min – 56%
    - 11-25 min – 88%
    - >25 min – nearly 100%

Table 2. Duration of cardiopulmonary resuscitation (CPR) in Cases of Drowning[3]

Duration of cardiopulmonary resuscitation (CPR) in Cases of Drowning	
CPR	**Recommendation**
When to initiate	• Patient with respiratory distress or respiratory arrest • Submerged for < 60 min with no obvious physical evidence of death (dismemberment, rigor mortis, decomposition, decapitation)
Continue until	• Signs of life reappear, rescuers are exhausted, or advanced-life-support team takes over, or scene becomes unsafe for rescuer; or
When to terminate	• After 30 minutes of high quality CPR without return of vital signs for a patient submerged in warm water (i.e. non-hypothermic) • After patient has been rewarmed to 30-33 °C/86-93 °F (if hypothermic) and asystole has persisted for >20 minutes for a patient submerged in cold water

ED/ICU CARE

- If not done in the field or in route: secure airway → improve oxygenation → stabilize circulation → gastric decompression → thermal insulation [1,3,7,25]
- Access mental status using Glasgow Coma Scale:
  - GCS > 13 → Clear cervical spine. Monitor O2 saturations, Observe for 4-6 hours.
    - Normal O2 saturation and lung examination → discharge home
    - O2 saturation < 95% or abnormal lung exam treat as though GCS ≤ 13
  - GCS ≤ 13 or O2 saturation < 95% → Clear cervical spine, monitor O2 saturation
    Give supplemental O2 to keep saturation ≥ 95% (non rebreather at 15L/min → CPAP (caution if vomiting is a concern) → intubate and ventilate with low TV (6 mL/kg), low PEEP 5-10 cm H2¬O (high PEEP may impair venous return resulting in hypotension), and volume ventilation (10 L/min).
- Otherwise, follow JTS CPG for Acute Respiratory Failure.[22]
- May require extracorporeal membrane oxygenation.
- Delay weaning from vent for 24 hours (even when gas exchange appears adequate - PaO2/ FiO2 ≥ 250).
- Surfactant washout will take 2-4 days of CPAP and PEEP to regenerate (unique to drowning and important in weaning from the vent).
- Inhaled albuterol and nebulized ipratropium for spasm
- Glucose – maintain between 80-140 mg/dL for ventilated patients.
- Special studies as indicated based on scenario.
  - CXR – regardless of patient's clinical appearance to be used as baseline.
  - EKG: Normothermic – asystole or cardiac arrest poor prognosis (follow standard protocols) Hypothermic – asystole and cardiac arrest should undergo prolonged aggressive resuscitation until normothermic or considered not viable.
  - Labs: complete blood count, comprehensive metabolic panel, glucose, Troponin I, PT/PTT, urinalysis, CK, urine myoglobin, urine drug screen, blood alcohol.
- Monitor:
  - Acid base status with arterial blood gas to determine:
    - Alveolar ventilation – acceptable PaCO2 and pH
    - Gas exchange – PaO2 > 60 mmHg on supplemental O2
    - Perfusion – no metabolic acidosis
    - Temperature with core temp (usually rectal)
    - Volume (BP, urine output, CVP, etc.). Initial resuscitation with crystalloid. Echo recommended prior to inotropic or vasopressors.
- Transfer to inpatient or ICU setting.

- Monitor for signs of infection (pulmonary or CNS), which may be due to bacteria, fungus, or ameba depending on water source. No role for prophylactic antibiotics to prevent pneumonia (incidence only 12 % of drowning cases) or steroids to reduce lung or neurologic injury; no need for routine cultures unless clinically indicated.
    - Pneumonia - fever, Gram stain and culture tracheal aspirates, respiratory status changes, chest radiographs. Increased risk while on vent.
    - Meningitis - neck stiffness, headache, change in mental status.
- Consider consults to critical care, trauma, neurosurgery, or hyperbaric medicine specialists.[23,24]
- Consider and treat precipitating factors of drowning: trauma, spinal cord injury, seizure, MI, arrhythmia, toxin, syncope or hypoglycemia.
- Monitor for sepsis, disseminated intravascular coagulation (DIC), and renal insufficiency/failure.
- CT head and neck: edema or loss of gray-white matter distinction strongly predicts poor outcome, but normal CT is of little prognostic value.
- POST-CPR CARE: consider 12-24 hours of therapeutic hypothermia in patients with return of spontaneous circulation (ROSC) to improve neurological outcomes similar to cardiac arrest.
    - Drowning victims with ROSC who remain comatose should NOT be actively rewarmed above 90-93°F/32-34°C.
    - Drowning victims with ROSC whose core temperature is ≥ 93°F/34°C should be cooled to 90-93°F/32-34°C as soon as possible.
- Cerebral O2 consumption decreases 5% for each reduction of 1°C within the range 37-20°C .

PULMONARY CONSIDERATIONS

- **Hypoxemia** – decreased levels of oxygen in the blood. This is the primary and most important physiologic insult due to impaired ventilation and gas exchange.[1-6,25]
    - Water in lungs washes out surfactant causing atelectasis (alveolar collapse), diminished gas transfer, ventilation perfusion mismatch, and hypoxia.
    - Non-cardiac pulmonary edema, may cause acute respiratory distress syndrome (ARDS) immediately or be delayed (even after normal CXR) necessitating observation for 4-6 hours.
    - Initially due to external water insult, then worsened by microvascular damage activating inflammatory cascade, which results in extravasation of fluid into alveoli worsening ventilation/perfusion (V/Q) mismatch.
    - Shunting –hypoxic pulmonary vasoconstriction increases pulmonary hypertension driving fluid into alveoli.
- **Hypercapnia** – increased levels of carbon dioxide in the blood resulting in acidosis most often due to breath holding or apnea.
- **Contaminated water** (petroleum, sewage, organic, mud, sand, etc.) – may increase lung injury and require bronchoalveolar lavage to cleanse. [1,6,11]

NEUROLOGIC CONSIDERATIONS

- Central Nervous System (CNS) is most susceptible organ to brief periods of hypoxemia and the major cause of morbidity/mortality.
- Full neurologic recovery rarely happens after: 10 min normothermic submersion or 40 min hypothermic submersion
- Full mentation (time dependent) → unconsciousness → complete brain death
- Highly metabolic areas of the brain are most susceptible – vascular end zones, gray matter, thalamus, hippocampus.

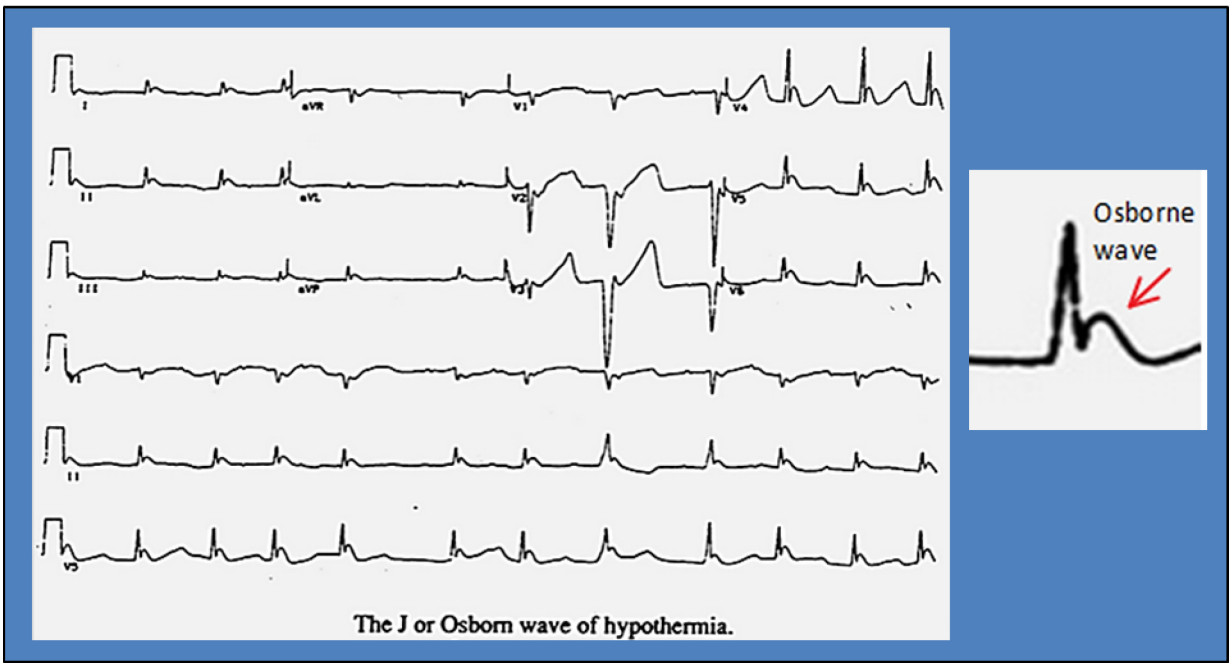
CARDIOVASCULAR CONSIDERATIONS

Major insult is hypoxemia and acidosis (two of the 5 ACLS "H's and T's") causing:

- Arrhythmias (most commonly): Tachycardia → Bradycardia → PEA → Asystole
- Ventricular fibrillation is not uncommon.
- Many ACLS interventions are ineffective with low core body temperatures, including pacing, atropine, lidocaine and defibrillation. Antiarrhythmics should be withheld for core temperatures of < 30 °C (86 °F), with emphasis placed on chest compressions and ventilations to maintain perfusion.[18]

If hypothermic, look for Osborne waves (extra deflection at the end of the QRS complex). See Figure 4.

Figure 4. EKG may demonstrate Osborn Waves (a small notch on the descending R-wave that is associated with hypothermia



HEMATOLOGIC & RENAL (ELECTROLYTE & METABOLIC) CONSIDERATIONS

- **Metabolic acidosis** – may progress from respiratory to metabolic and be severe.[1,4,5,3]
- **Electrolyte shifts** – no practical effects in humans (evidence of derangements was from old animal studies).
- **Hemolysis** – no practical effects in humans (evidence of DIC and hyperkalemia were from old animal studies).
- **Diving reflex** – massive vagal nerve stimulation from cold water immersion shunts blood to brain and cardiac tissue, away from skin/extremities/vascular beds and is coupled with bradycardia and decreased metabolic demand which sustains mean arterial pressure (MAP) with decreased cardiac output.[1,2,4,11]

SWIMMING INDUCED PULMONARY EDEMA (SIPE)

Most commonly presents in individuals conducting sustained strenuous surface swimming in cold water (i.e. NSW, Marine Combatant Divers, MARSOC Critical Skills Operators, Marine combat swimmers, special operators, scuba divers, and triathletes). SIPE is reported in 1.4% of triathletes and recurrence is not uncommon. Symptom severity can range from full recovery within 24 hours to death.

Risk Factors: hypertension, female, swimming ≥ 1.2 miles, prior history of SIPE

Diagnostic Criteria (during or immediately after exertional water immersion/swimming):

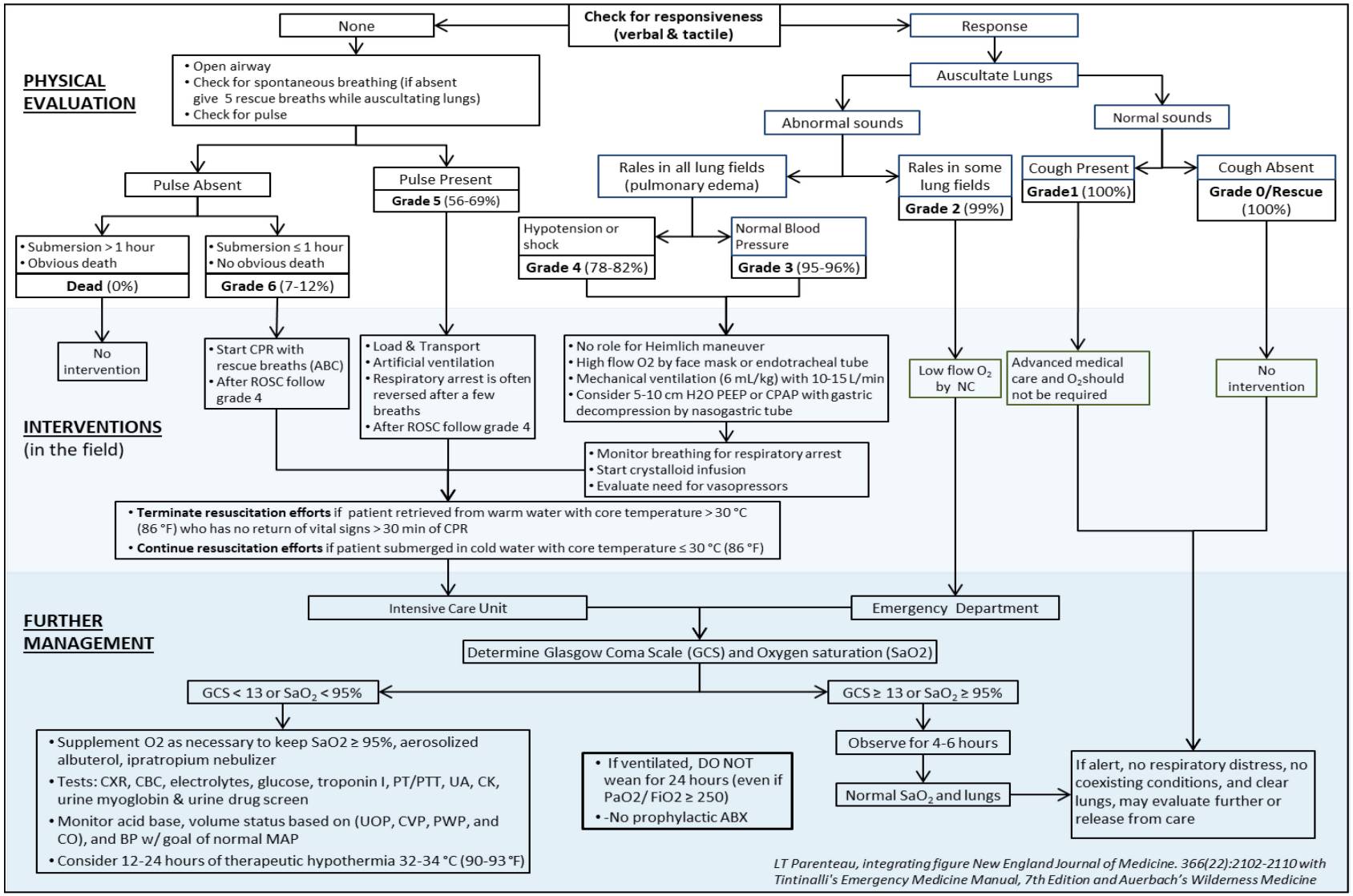
- Dyspnea or cough
- Hypoxemia
- +/- Hemoptysis
- CXR shows pulmonary edema or infiltrates that resolve w/in 48 hours.
- Absence of underlying pulmonary infection or aspiration of water

Pathophysiology: unknown; thought to be due to:

- Elevated pulmonary artery pressure - 'fracturing' pulmonary capillaries due to vascular stress caused by ↑ preload, afterload, and vascular resistance due to central pooling of blood from peripheral vasoconstriction.
- Diastolic dysfunction.

Management: typically resolves with rest within 24-48 hours. Hospitalization with diuretics and supplemental oxygen for severe cases.

DROWNING FLOWCHART


Check for responsiveness (verbal & tactile)
None
Response
PHYSICAL EVALUATION
• Open airway
• Check for spontaneous breathing (if absent give 5 rescue breaths while auscultating lungs)
• Check for pulse
Auscultate Lungs
Abnormal sounds
Normal sounds
Pulse Absent
Pulse Present
Grade 5 (56-69%)
Rales in all lung fields (pulmonary edema)
Rales in some lung fields
Grade 2 (99%)
Cough Present
Grade1 (100%)
Cough Absent
Grade 0/Rescue (100%)
• Submersion > 1 hour
• Obvious death
Dead (0%)
• Submersion ≤ 1 hour
• No obvious death
Grade 6 (7-12%)
Hypotension or shock
Grade 4 (78-82%)
Normal Blood Pressure
Grade 3 (95-96%)
No intervention
• Start CPR with rescue breaths (ABC)
• After ROSC follow grade 4
• Load & Transport
• Artificial ventilation
• Respiratory arrest is often reversed after a few breaths
• After ROSC follow grade 4
• No role for Heimlich maneuver
• High flow O2 by face mask or endotracheal tube
• Mechanical ventilation (6 mL/kg) with 10-15 L/min
• Consider 5-10 cm H2O PEEP or CPAP with gastric decompression by nasogastric tube
Low flow O_2 by NC
Advanced medical care and O_2 should not be required
No intervention
INTERVENTIONS (in the field)
• Monitor breathing for respiratory arrest
• Start crystalloid infusion
• Evaluate need for vasopressors
• Terminate resuscitation efforts if patient retrieved from warm water with core temperature > 30 °C (86 °F) who has no return of vital signs > 30 min of CPR
• Continue resuscitation efforts if patient submerged in cold water with core temperature ≤ 30 °C (86 °F)
FURTHER MANAGEMENT
Intensive Care Unit
Emergency Department
Determine Glasgow Coma Scale (GCS) and Oxygen saturation (SaO2)
GCS < 13 or SaO_2 < 95%
GCS ≥ 13 or SaO_2 ≥ 95%
• Supplement O2 as necessary to keep SaO2 ≥ 95%, aerosolized albuterol, ipratropium nebulizer
• Tests: CXR, CBC, electrolytes, glucose, troponin I, PT/PTT, UA, CK, urine myoglobin & urine drug screen
• Monitor acid base, volume status based on (UOP, CVP, PWP, and CO), and BP w/ goal of normal MAP
• Consider 12-24 hours of therapeutic hypothermia 32-34 °C (90-93 °F)
• If ventilated, DO NOT wean for 24 hours (even if PaO2/ FiO2 ≥ 250)
• -No prophylactic ABX
Observe for 4-6 hours
Normal SaO_2 and lungs
If alert, no respiratory distress, no coexisting conditions, and clear lungs, may evaluate further or release from care
LT Parenteau, integrating figure New England Journal of Medicine. 366(22):2102-2110 with Tintinalli's Emergency Medicine Manual, 7th Edition and Auerbach's Wilderness Medicine

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Drowning casualties

INTENT (EXPECTED OUTCOMES)

Drowning casualties with cardiac arrest/CPR who have return of spontaneous circulation receive targeted temperature management therapy.

PERFORMANCE/ADHERENCE METRIC

Number and percentage of drowning casualties with cardiac arrest/CPR who have return of spontaneous circulation who receive targeted temperature management therapy.

DATA SOURCE

- Patient Record (paper medical record and electronic medical record)
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

- The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.
- The system review and data analysis will be performed by the JTS Chief and JTS PI Branch
- The Ustein Uniform Reporting Data form for Drowning will be used.

RESPONSIBILITIES

It is expected that medical department personnel, particularly of the sea services (U.S. Navy, U.S. Marine Corps, U.S. Coast Guard, and U.S. Merchant Marine) will become familiar with these clinical practice guidelines and incorporate them into both operational planning and emergency medical response plans.

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APPENDIX A: MEDICAL DEFINITIONS AND TERMINOLOGY

WORLD HEALTH ORGANIZATION DEFINITIONS[1,2]

- **Immersion**: "some portion of the body is covered in water" (i.e. head is out of the water)
- **Submersion**: "during submersion, the entire body, including the airway, is under water" (i.e. head is in the water)
- **Submersion injuries**: "water-related conditions that do not involve the airway and respiratory systems
- **Drowning**: "the process of experiencing respiratory impairment from submersion/immersion in liquid." The drowning process begins with respiratory impairment as the person's airway goes below the surface of the liquid (submersion) or water splashes over the face while being completely in a liquid (immersion).[1-3] Subdivided into 3 categories:
  - **Fatal drowning**: "person dies at any time as a result of submersion/immersion with respiratory impairment."
  - **Non-fatal drowning with morbidity**: "person is injured at any time as a result of submersion/immersion with respiratory impairment, but survives."
  - **Non-fatal drowning without morbidity**: "person survives uninjured from submersion/immersion event with respiratory impairment, but survives."
- **Water rescue**: "submersion or immersion incident without evidence of respiratory impairment."[1-4]
- **Shallow water blackout**: "hyperventilating to decrease hypercapnic drive to breathe and prolong ability to stay under water such that hypoxemia results in unconsciousness." The compulsion to breathe from hypercapnia (acidosis) is physiologically more potent than hypoxemia (except when subverted by hyperventilation – i.e. lowering CO2).[5]
- **Asphyxia**: "a condition where breathing stops and both hypoxia and hypercapnia occur simultaneously due to: (1) the absence of gas to breathe; (2) the airway being completely obstructed; (3) respiratory muscles being paralyzed; or (4) respiratory center failing to send impulses to breathe." Running out of compressed air is a common cause of asphyxia in SCUBA diving.[1,5,6]
- **Drowning after shallow water diving**: Diving into shallow water makes concussion, head injury, and cervical spine (C-spine) injury more common, so rescuer must balance C-spine precautions against time of extraction (normally in drowning C-spine precautions are not required because the risk is < 0.5%). Also consider drug/alcohol impairment.[1,6]
- **Warm water drowning**: Unplanned submersion → panic and violent struggle → gulping / swallowing of air and water → breath holding until hypoxia leads to unconsciousness → gag reflex relaxing resulting in passive influx of water → drowning if PFD does not keep airway out of the water.[1]
- **Cold water drowning**: Impacts every organ system similar to complex trauma. Sudden immersion in cold water (< 91.4°F/33 °C) causes panic, reflexive gasp for air and rapid breathing making:[1-5, 8-10]
  - Inhalation/aspiration of water is more likely.
  - Core temperature drop causing arrhythmias, confusion, incapacitation (diminished strength and coordination) increasing the chance of drowning.

- Water conduct heat away from the body 25 times faster than air leading to immersion hypothermia – impaired meaningful movement usually precedes.[1,6,8]

TERMS NOT TO USE

Terms NOT to use as they do not have diagnostic or therapeutic distinctions (although still widely used by medical professionals and the lay public, so important to be familiar with them).[1,4,5,7,8,11]

- **Wet drowning**: "Fluid is aspirated into the lungs." Aspiration of water occurs in only 80-90% of cases and does not change the treatment or management.
- **Dry drowning**: "Fluid is not aspirated; death is due to laryngospasm and glottis closure." Asphyxia still occurs secondary to laryngospasm occurring in 10-20% of cases, but no change in management. Difference is only relevant at autopsy.
- **Secondary drowning/Delayed onset of respiratory distress**: Varied definitions with death occurring from 1-72 hours after initial resuscitation due to acute respiratory distress syndrome (ARDS). Fifteen percent of victims conscious at initial resuscitation subsequently die from ARDS.
- **Near drowning**: "Suffocation by submersion in a liquid with at least temporary survival. Death from near drowning occurs after 24 hours." Caused confusion because it had 20 different published definitions, most commonly if the person is rescued at any time, thus interrupting the process of drowning.
- **Immersion syndrome**: "Sudden death immediately following submersion in very cold water" thought to be caused by vagal nerve stimulation resulting in overwhelming bradycardia.
- **Active drowning**: Witnessed drowning
- **Passive drowning**: Unwitnessed drowning
- **Fresh water vs. salt water drowning**: Typical human aspiration during drowning is 4 mL/kg. To change blood volume requires 8mL/kg, or to alter electrolytes require 22 mL/kg. Therefore, not clinically significant and instead focus remains on hypoxemia, acidosis, and pulmonary injury rather than electrolyte or volume status.
  - **Freshwater**: Hypervolemia (in animal models only, not humans, so no clinical relevance)
  - **Saltwater**: Hypovolemia with hypernatremia (in animal models only, not humans, so no clinical relevance)

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APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Emergency General Surgery in Deployed Locations (CPG ID:71)

This CPG will guide providers in the evaluation and treatment of patients with acute general surgical needs in potentially austere locations

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GOAL

The goal of this clinical practice guideline is to provide guidance on the treatment of acute surgical conditions in the deployed environment. These guidelines are not intended solely for clinical care, but to help unit commanders and supporting medical components to consider tactical and resource constraints relevant to the management of acute surgical conditions in order to optimize patient care in the expeditionary setting.

BACKGROUND

Austere surgical environments in a deployed setting can be significantly different from what medical personnel experience in garrison. The lack of diagnostic and treatment modalities can significantly limit management options. While deployed austere surgical capabilities are established for the primary purpose of trauma care and hemorrhage control, surgeons are still likely to deal with other urgent surgical issues.[1,2,3] The aim of this guideline is to provide surgeons in austere locations, as well as command staff, with decision support for the care of emergency general surgery patients.

EVALUATION

Depending on surgical team capabilities, a history and physical examination will be the mainstay of the diagnostic evaluation. In addition, the majority of surgical teams also have the capability for ultrasound and point of care blood analysis to allow for limited imaging and laboratory assessment. The most common non-traumatic surgical diagnoses to be encountered are shown in the table below:[1,2,3]

Table 1. List of Common Surgical Diagnoses

List of Common Surgical Diagnoses
Kidney stones
Appendicitis
Hernia
Testicular Torsion
Cholecystitis
Inflammatory bowel disease
Bowel obstruction
Ectopic pregnancy
Obstetric emergency
Ruptured ovarian cyst
Anorectal disorders (abscess, hemorrhoids, fissure)
Diverticulitis
Soft tissue infection/Abscess
Gastrointestinal bleeding

All the above diagnoses are familiar to general surgeons and history and physical examination alone will yield a high diagnostic accuracy.

In the non-deployed setting, the most important part of the evaluation is determination of the patient's clinical stability followed by timing of surgical intervention if warranted. In the resource-limited environment, many additional factors have to be considered in order to optimize the care of the patient with an acute surgical condition. Determining whether the patient is best served by having emergency surgery in an austere or resource-limited location or by transferring to a higher role of care is multifactorial.

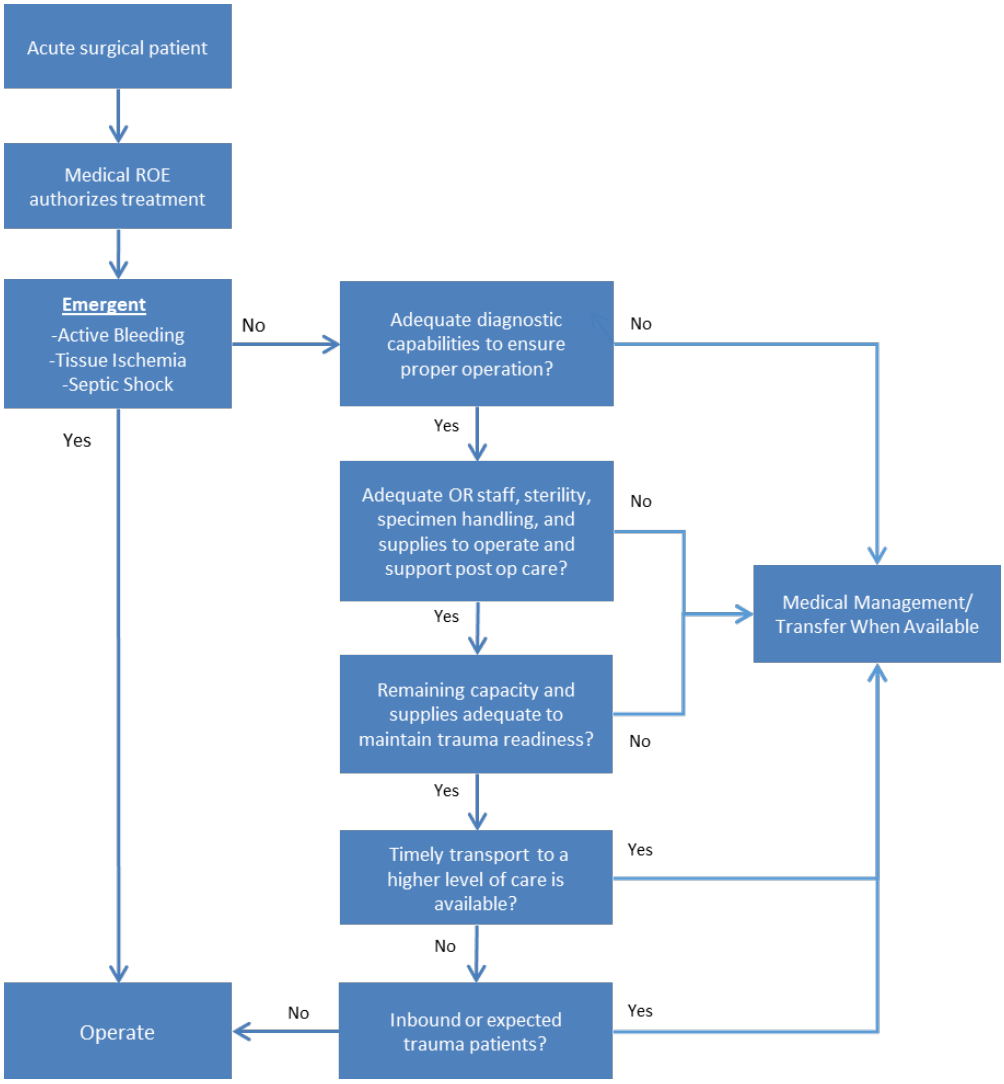
The deployed surgeon must consider complex tactical and clinical data in decision-making for clinically urgent situations. The surgeon must determine if the patient is emergent, requiring immediate intervention (e.g., ongoing bleeding, suspected tissue ischemia, or evidence of septic shock) or is nonemergent (localized findings, mild systemic symptoms). The clinical determination of stability is the most challenging for the deployed surgeon and their command staff alike. Except for gastrointestinal bleeding and tissue ischemia (e.g., testicular torsion, strangulated hernia), most patients with the previously mentioned surgical diagnoses will tolerate a delay of several hours with antimicrobial therapy before surgical intervention without increased morbidity or mortality. Therefore, these patients can be considered nonemergent.[4] While this delay in surgical treatment may not be ideal, it may be well within the standard of care. Some non-emergent invasive surgical procedures may be indicated in the austere environment depending on time to transport and complexity of the proposed intervention. For example, drainage of a soft tissue abscess may be indicated if transport to higher level of care will take multiple days.

DECISION MATRIX

Austere surgical environments and acute care surgery conditions are diverse and strict rules to cover every conceivable diagnosis would be inappropriate to a surgeon and commander. In all cases, the final clinical decision should rely on the surgeon at the forward location to act in the best interest of the patient. In real-world situations, the difference between emergent and nonemergent conditions can be clinically ambiguous when a host of additional factors are considered.

A graphical representation of considerations is presented above and discussed along with additional factors below.

Figure 1. Decision Matrix



1. Non-coalition patients: Patients may include local nationals, partner nation forces, contractors, foreign citizens, etc. Theater medical rules of eligibility (ROE) will dictate what care may be rendered, what transport resources will be available for use, and where these patients are to be transported for follow-on care. The principles of care should be equivalent to those provided to US/Coalition/enemy combatant patients, although operative decisions must be made in the context of the system of care in which that patient will be managed. Understanding of the medical ROEs and knowledge of the capabilities of the relevant systems of care are paramount.

2. Diagnostic capability: When conditions permit, the same preoperative, intraoperative, and postoperative standards of care should be provided to patients in a deployed location as in the United States. If a patient is non-emergent, reasonable attempts should be made to obtain appropriate diagnostic tests prior to surgical intervention, even if that requires transport to a higher role of care.

3. Operative team and supplies: Austere conditions are potentially not sterile and operative personnel may lack the subspecialty expertise for certain procedures or may be lacking the most appropriate supplies or

equipment needed. When conditions permit, procedures performed should be within the scope of practice of the deployed surgeon or should be done in close consultation with the appropriate subspecialist. In addition, specimens should be handled appropriately. Incidental neoplasms, while uncommon, do occur. Resected tissue should be evaluated by a pathologist and should be preserved appropriately for evaluation.

4. Holding capacity: If an operation is performed, the patient will have to be cared for postoperatively until transport or discharge is possible. If holding capacity is limited, a plan for transfer or discharge should be in place prior to the arrival of trauma patients.

5. Mission readiness: Non-emergent operations should not compromise the primary mission of the deployed team or the team's readiness to receive trauma patients.

6. Transport/receiving capability: If considering transport of the patient, the capability of transport vehicles and personnel may vary as well as the capabilities of receiving facilities. Knowledge of these capabilities and transport times are critical to making safe decisions. To the extent possible, communication with the transport team and the receiving provider should be made for patient safety and continuity of care.

7. Minor Procedures: If a procedure can be done in a clinic room, it can likely be done in an austere setting (i.e. thrombosed hemorrhoids, simple incision and drainage). Elective procedures should not be performed in the deployed setting. Elective minor procedures such as routine skin or soft tissue biopsies should not be done at a Role 3 unless in-house pathology is available as specimens can become lost or dry out while in transit for pathologic evaluation.

8. Teleconsultation: Whenever possible, particularly when surgical intervention for nonemergent conditions is being considered or when it is uncertain whether the condition is emergent or nonemergent, teleconsultation should be obtained with the surgeon at the next higher role of care if it is expected that the patient will require transfer postoperatively.

With the above listed considerations in mind, if the patient's clinical status is such that a delay in surgical treatment is likely to result in death or significant morbidity, they should be considered emergent and an operation performed. If not, strong consideration should be made to transfer the patient to a higher level of care unless, after considering the above points, in the surgeon's opinion the benefits outweigh the risks.

TREATMENT

The best interest of the patient is always the focus of decision-making for the surgeon; however, commanders are required to keep the tactical environment and risks aligned with the overall mission goals. In a setting of limited medical assets, determining the patient's clinical stability for transport as well as the availability of transport are extremely important factors to consider when determining the best treatment. The determination of emergent or nonemergent surgical status is therefore paramount and that decision may be appropriately influenced by availability and timing of transport to higher level of care. This distinction is based on the judgement of the surgeon on the ground, but emergent usually involves patients with tissue ischemia, ongoing bleeding, or evidence of septic shock. Emergent surgery should be done with treatment rendered based on damage control principles rather than in-garrison standards of care.[5] As in trauma, principles of surgical care should prioritize controlling sources of contamination and bleeding, with definitive care (e.g., anastomoses or ostomies) deferred for Role 3 or 4 facilities. In addition, heavily contaminated wounds should be left open for further washouts in a more sterile environment, if applicable.

Patients classified as nonemergent should be treated with the best available medical therapy and await transportation to a level of care that can definitively treat and hold patients for the perioperative period (See Decision Matrix; likely Role 3 or 4). This allows the austere surgeon to conserve supplies, equipment, and manpower for future emergent patients. Medical management may consist of broad spectrum antibiotics, resuscitation with fluids, pain control and supportive care as indicated. For some commonly encountered acute surgical diagnoses, medical management with ongoing close surgical observation may actually constitute definitive therapy.[6-10] The austere surgeon and the command element should have an awareness of the treatment options and how they fit into the multifactorial decision making. Treatment may entail medical management and observation within the forward surgical setting, transfer to higher level of care for definitive diagnosis, or disposition to quarters with a medical or non-medical attendant. Commanders and patients should be aware of these options with the associated risks. Clinical observation always carries the risk of deterioration requiring surgical intervention, therefore transfer to a higher level of care may be indicated even when non-operative management is selected.

While tailored antimicrobial therapy may be preferred for some diagnoses, this may not be possible given limited medication options in most austere packs as well as diagnostic uncertainty. Antibiotics should default to broad spectrum agents such as ertapenem given its widespread availability in austere surgical team packs, ease of administration and broad coverage. Given the low cross reactivity with penicillin-allergic patients, this common allergy should not dissuade surgical teams from administering ertapenam to patients with penicillin allergy.[11] Alternatives are disease specific, but consideration should be given to broad coverage from the onset of care. Lack of microbiology, culture and basic lab capability, combined with virulent local pathogens in many austere settings dictate this approach.

Unique to the military surgical environment is the need for maintain mission-readiness for the patient and their deployed unit. With mission requirements of foremost importance, the possibility of treating common surgical diseases, such as appendicitis and cholecystitis, non-operatively in an austere surgical setting should be considered and a high likelihood of success may be expected.[7,12] In-theater surgical treatment in austere locations with rapid return to duty may also be acceptable if resources and mission requirements permit. While patients are commonly instructed to limit physical activity for 6 weeks, there is little evidence-based support for this practice.[13] In cases of soft tissue abscesses and uncomplicated appendicitis, the expected post-operative morbidity would likely be low and the patient potentially safely and well-managed in the austere setting. However, for a nonemergent patient with suspected appendicitis seen in the Role 2 setting, strong consideration should be given to transferring the patient to a higher level of care in order to confirm the diagnosis with CT scan or if laparoscopic capability is available.

Nonemergent patients with acute cholecystitis should not be operatively managed at the Role 2 unless laparoscopic equipment, the appropriate operating room table and the ability to perform a cholangiogram (either flat plate or C-arm) is available as this is the standard of care and very rarely does a patient with acute cholecystitis require an emergent open cholecystectomy.

Although surgical site infections have been reported to be similar to civilian outcomes in one published experience, the surgical site infection rates are not negligible and other non-infectious perioperative complications may occur.[14] While transfer to a location that can deal with post-operative complications most effectively would be ideal, if the austere surgical team can safely and effectively perform the operation and manage perioperative complications an operation may be considered. Additionally, return to duty status should be taken into consideration along with long term post-operative morbidity such as hernia formation, the need for advanced pain management requirements (difficult in the austere or combat environment) and immediate post-operative complications.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients who undergo surgery for non-trauma diagnoses by deployed surgical teams.

INTENT (EXPECTED OUTCOMES)

- Patients receive initial treatment with antibiotics if infectious diagnosis (appendicitis, cholecystitis, abscess, diverticulitis).
- Emergency general surgery cases are performed at Role 3 or Role 4; if performed at Role 2, the indication to proceed with surgery rather than evacuate to higher level of care should be clearly documented.

PERFORMANCE/ADHERENCE METRICS

- Number and percentage of patients in the population of interest with an infectious diagnoses who receive antibiotics at the same role of care where diagnosed.
- Number and percentage of patients in the population of interest with emergency general surgery performed at Role 3 or Role 4; or if performed at Role 2, the indication to proceed with surgery rather than evacuate to higher level of care is clearly documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- Morbidity and Mortality Conference Reports

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

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Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Emergency Life-Saving Cranial Procedures by Non-Neurosurgeons in Deployed Setting (CPG ID:68)

This CPG applies to military non-neurosurgeons in a forward deployed location with surgical capability (Role 2 surgical teams that meet capability requirements) outside of the United States.

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INTRODUCTION

The U.S. Military has deployed combat assets throughout the world. As such, catastrophic injuries can and do occur in austere environments with limited or no resources. It is understood that the standard of care for the treatment of severe traumatic brain injury includes the direct evaluation and treatment by a trained neurological surgeon.[1,2] Because there are not enough neurosurgical assets to support all missions, and because timely critical care air transport of severely brain injured servicemen and women is not always available depending on the location, and because severe and catastrophic brain injury can be rapidly fatal, the U.S. Military has recognized the occasional need for certain non-neurosurgeons (usually general surgeons) to perform cranial procedures far forward.[3] Data from the DoD Trauma Registry demonstrate that craniectomy procedures have been documented at Role 2 surgical facilities in Iraq and Afghanistan 36 times, with indeterminate success. There is some precedent for this practice within the literature,[2,5-6] including reference to the need for this practice as early as World War II.[7] This concept is addressed to a certain extent in the treatise on War Surgery from the International Committee of the Red Cross.[8] In the aforementioned references, there is tacit acknowledgement that neurosurgical procedures are possible in austere locations with appropriate training and resources. With this in mind, it has become the responsibility of the U.S. Military neurosurgical community to ensure that our deployed servicemen and women receive the best care possible from non-neurosurgical colleagues. The purpose of this clinical practice guideline is therefore to provide specific and tailored guidelines for the performance of cranial procedures by non-neurosurgeons. The document has been developed jointly by the neurosurgical departments of all three services to support the non-neurosurgeon faced with this difficult situation.

This CPG was developed by consensus opinion from the Joint Trauma System, neurosurgical members of the American Association of Neurological Surgeons/Congress of Neurological Surgeons (AANS/CNS), Joint Military Committee and the AANS/CNS Section of Neurotrauma. This document has been reviewed by and is supported by the Defense and Veterans Brain Injury Center.

Definitions
Craniotomy: The removal of part of the skull for the purposes of accessing contents of the calvarial vault, and then replacing the bone in its original position using plates and screws.
Craniectomy: The removal of portions of the skull for the purposes of accessing the contents of the calvarial vault without replacement of the bone.
Ventriculostomy: The placement of a small catheter within the body of the lateral ventricle through a small burr hole drilled approximately 10-11 cm posterior to the glabella and 2.5-3 cm lateral to midline. This catheter can be used to drain cerebrospinal fluid and to measure intracranial pressure.
Subdural hematoma: The accumulation of blood within the subdural space, usually as a result of trauma, and best diagnosed with a computerized tomography (CT) scan. Some general indications for surgery include hematomas > 1 cm in maximal thickness especially if associated with > 5 mm midline shift on a non-contrast CT of the head.
Epidural hematoma: The accumulation of blood within the epidural space, usually as a result of trauma, and best diagnosed with a CT scan. Common locations include the temporal region (middle cranial fossa) due to laceration of the middle meningeal artery. Some general indications for surgical intervention may include a hematoma > 30 mL in size on non-contrast CT head, especially if associated with evidence of uncal herniation. This can be clinically diagnosed when there is a dilated, unreactive pupil (3rd cranial nerve compression) with contralateral hemiparesis, with or without hemodynamic instability (hypertension, bradycardia, respiratory variation).
Intracerebral hemorrhage: The accumulation of blood within the parenchyma of the brain. This can result from trauma, and is best diagnosed with a CT scan.
Penetrating brain injury: Injury to the brain resulting from penetration of the skull, dura, and brain parenchyma by a foreign body.

INDICATIONS TO PERFORM CRANIAL PROCEDURES IN AUSTERE SETTING

The decision to perform a neurosurgical intervention in an austere location is best made with the telemedicine support of a neurosurgeon.

Telemedicine consult may be obtained from the closest neurosurgeon in the evacuation chain. In addition, worldwide neurosurgery consultation is available at:

- WRNMMC: 301-295-4000 (comm), 312-295-4000 (DSN) or 240-381-2528 (comm).
- SAMMC: 210-539-0817 (comm) or 312-429-2500 (DSN), 210-916-2500 (comm).
- Ask the hospital operator to contact the attending neurosurgeon on call.

In some locations, a CT scan may be available, greatly facilitating the appropriate intervention.

When a CT scan is not available, there is a high risk that procedures may be performed without correct localization of pathology. It is therefore necessary to make an accurate diagnosis, appropriately resuscitate, and exhaust all medical interventions prior to performing a procedure in this environment. Regardless of whether a CT scan is available, the indications for surgical intervention are clinical.

WHEN TO PERFORM CRANIAL PROCEDURES

- A cranial procedure is recommended after teleconsultation with neurosurgery (when possible), *and*
- Severe closed supratentorial brain injury with a presenting GCS ≤ 8 AND lateralizing cortical dysfunction such as unilateral dilated pupil or hemiparesis
  - Accompanied by hemodynamic dysfunction: hypertension, bradycardia, and respiratory variation (Cushing's reflex), *or*
  - Failure of maximal critical care management per the Neurosurgery and Severe Head Injury CPG2 to stabilize the patient. This may manifest by the occurrence of a new lateralizing cortical finding (hemiparesis, rapidly expanding pupil) and/or further decline in GCS off of sedation, *and*
- Evacuation to a neurosurgeon is not available within approximately 4 hours of injury, *and*
- Surgeon training and resources are adequate. See Appendix A (Training) and Appendix B (Resources).

WHEN NOT PERFORM CRANIAL PROCEDURES

- Clinical condition and neurologic status stabilized or improved with aggressive medical management.
- Surgeon and resources are not adequate. See Appendix A (Training) and Appendix B (Resources).
- The patient has a post-resuscitation GCS = 3 with bilateral fixed and dilated pupils. This is non-survivable.

CHECKLIST/PROCEDURES FOR CRANIECTOMY

1. Establish teleconsultation with neurosurgeon. Video consultation is preferred. If unable to communicate with a neurosurgeon, recommend a multi-disciplinary discussion that includes the local command authority prior to proceeding.

2. Make every effort to evacuate the patient to a facility where neurosurgery is available within approximately 4 hours.

3. Assess indications for craniectomy.
4. Assess availability of follow-on care.
5. Ensure that maximal medical/critical care management and resuscitation of the patient's intracranial condition has occurred. This should include appropriate blood component resuscitation, 3% saline, anticonvulsant, sedation, etc. in accordance with the JTS Neurosurgery and Severe Head Injury CPG.[2]
6. Ensure that the surgeon training and the facility resources are adequate.
7. If all of the above indications are met, then, in consultation with a neurosurgeon (when possible), consider intervention as follows: (Note: Review Emergency War Surgery Manual for further details.[3])

CLOSED HEAD INJURY

If no CT scan is available, an accurate neurological examination must be obtained for the purposes of localizing the lesion. A skull X-ray may improve localization in cases of skull fracture or penetrating brain injury.

Proper positioning of the patient is very important.

1. Avoid any compression of the neck to assure unhindered jugular venous outflow.
2. The head should be positioned slightly higher than the chest.
3. Rotate the head 30-40° off midline such that the side being operated on is highest.
4. Mark the midline of the scalp, as well as the location of anticipated burr hole and craniotomy incisions, prior to draping the head.

Once localized, exploratory burr holes will be made over the frontal, temporal and parietal convexities using electric drill for the purposes of identifying a hematoma.

1. If necessary, the dura can be opened carefully through the burr hole following cauterization if hemorrhage is subdural.
2. If evidence of epidural or subdural bleeding or high intracranial pressure is encountered, a craniectomy should be performed.
3. Burr holes alone are unlikely to be helpful in the setting of severe TBI.

Once the decision to proceed with craniectomy is made, the dura must be carefully separated from the inner table of the skull (Penfield 1-3 instruments) and the burr holes connected with the electric drill using either a side cutting bit or a "matchstick" bit.

1. An appropriately sized craniectomy is usually at least 15cm long in the sagittal plane and 12cm in height in the coronal plane, however a smaller craniectomy may be advisable in the far-forward setting.
2. Take care to stay off midline in order to avoid injury to the superior sagittal sinus.
3. If the hematoma is epidural, it must be evacuated and the bleeding source cauterized.
4. If subdural, the dura must be opened, the hematoma evacuated, and if visible, the bleeding source cauterized.
5. Do not replace the bone.
6. If not visible, do not search for a bleeding source.
7. If subdural hematoma, do not close the dura.

In all circumstances, the scalp must be closed.

If the brain herniates rapidly out after dural opening, close the scalp immediately.

PENETRATING HEAD INJURY

Penetrating brain injury is one of the most challenging indications for cranial procedures performed by neurosurgeons.

1. Exploration without teleconsultation from a neurosurgeon is not recommended.
2. There is often deep and uncontrollable bleeding that may not be evident on the cortical surface.
3. Surgical exploration below the surface of the brain is NOT recommended.
4. Surgical intervention should be limited to removing bone, opening the dura, controlling bleeding, and closing the skin rapidly.

If cranial contents are herniated from either the entry or exit wound, allow this to continue. Do not close the wound.

Adequately resuscitate as necessary, and transport at the soonest opportunity.

If evacuation to a higher level of care is not possible, recognize that intervention in this case may be futile.

PERFORMANCE IMPROVEMENT MONITORING

POPULATION OF INTEREST

All patients at a Role 2 surgical capability with an initial GCS ≤ 8 AND diagnosis of traumatic brain injury.

INTENT (EXPECTED OUTCOMES)

1. Cranial procedures will be performed by non-neurosurgeons only when a neurosurgeon is not available within approximately 4 hours.
2. Only patients with following criteria undergo decompressive craniectomy by a non-neurosurgeon:
    a. Traumatic brain injury with post-resuscitation GCS 4-8 AND
    b. Lateralizing neurologic signs AND
    c. Hemodynamic dysfunction (hypertension, bradycardia, and respiratory variation: i.e. Cushings reflex) OR failure of maximal critical care management (new lateralizing cortical finding such as hemiparesis or rapidly expanding pupil, and/or further decline in GCS off of sedation).
3. Non-neurosurgeons will perform emergency life-saving cranial procedures only after teleconsultation with a neurosurgeon.
4. Non-neurosurgeons will perform emergency life-saving cranial procedures using an electric drill and saw.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with documentation of anticipated length of time > 4 hours to arrive at a facility with a neurosurgeon.

2. Number and percentage of patients in the population of interest who have the following indications documented:

   a. Traumatic brain injury with post-resuscitation GCS 4-8 AND

   b. Lateralizing neurologic signs AND

   c. Hemodynamic dysfunction (hypertension, bradycardia, and respiratory variation: i.e. Cushing's reflex) OR failure of maximal critical care management (new lateralizing cortical finding such as hemiparesis or rapidly expanding pupil, and/or further decline in GCS off of sedation).

3. Number and percentage of patients in the population of interest who have documentation of teleconsultation with a neurosurgeon.

4. Number and percentage of patients in the population of interest who have documentation of the use of an electric drill and saw for the procedure.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- ICU flow sheet

SYSTEM REPORTING & FREQUENCY

- The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.
- The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: TRAINING FOR CRANIAL PROCEDURES IN AUSTERE SETTING

The training and experience of individual surgeons is a factor that must be considered on a case-by-case basis when deciding whether to perform a neurosurgical intervention in an austere environment. In some cases a prolonged evacuation may be preferred over intervention by an untrained surgeon, while in other cases, such as with host national casualties, evacuation is not an option and the deployed care available is the only option.

Since neurosurgical training is not standard training for the majority of general surgeons, the following recommendations have been established to allow general surgeons to better prepare for austere surgical missions. The main purpose is to establish a guideline that, per expert opinion, optimizes the benefit: risk ratio for injured patients cared for in the forward deployed, resource limited environment.

Recommendations for non-neurosurgeons to perform cranial procedures for specific clinical indications in austere environments include:

- Board certified/eligible general or head and neck surgeon
- Participation in at least 10 cranial procedures supervised by a neurosurgeon. At least 1 of these procedures should occur within 1 year of scheduled deployment.
- Completed a cranial simulator course within 1 year of deployment run by a board certified/board eligible neurosurgeon (i.e. Emergency War Surgery Course or ASSET+).

Training recommendations do not constitute a credentialing requirement. Individual surgeons may perform cranial procedures when the clinical situation, available resources, and analysis of the risks and benefits of both surgical and medical management favor surgical intervention.

In cases where a surgeon has not completed the recommended training, the risk of neurosurgical intervention may outweigh the benefit and medical management may be preferred.

For context and perspective, the minimum number of trauma craniotomies required to graduate a neurosurgical resident trainee is 40. The committee of subject matter experts arrived at the number 10 in an effort to balance forward requirements with what was thought to be the necessary competency given the current training environment.

*Recommendations based on Consensus opinion American Association of Neurological Surgeons/Congress of Neurological Surgeons Joint Committee of Military Neurosurgeons, meeting 24 Apr 2017.

APPENDIX B: RESOURCES FOR CRANIAL PROCEDURES IN AUSTERE SETTING

Neurosurgical intervention is greatly facilitated by obtaining the recommended supplies and equipment. The risk of neurosurgical intervention is higher when proper equipment is not available. Every effort should be made to obtain the necessary supplies and equipment if neurosurgical procedures are within the scope of a surgical team's mission. If only a Gigli saw and Hudson brace are available to an inexperienced provider, the risk of neurosurgical intervention may outweigh the benefit, and medical management may be preferred.

Recommended resources necessary to support non-neurosurgeons who may have to perform cranial procedures in an austere environment should include all of the following:

1. Tele-conference capability (video-teleconference capability preferred).
2. Emergency cranial pack that includes an electric drill with cranial perforator bit and matchstick or cutting ball, a Leksell Rongeur, Penfield instruments, bipolar cautery, Dural substitutes, and hemostatic agents (i.e. gel foam, surgicel, etc.). A Gigli saw and Hudson drill may be included as back up should the electric drill fail during the procedure.
3. Critical care capabilities.

NOTE: Non-invasive measures of intracranial injury are an emerging technology that may be utilized to improve localization of injury or superficial hematoma.

Non-invasive Measurement Resources

1. Quantitative pupillometry: This is a small hand-held device that initiates a miotic pupillary response, records the speed of the response, and supplies a normative pupillary index (NPI).[1]
   - As intracranial pressure increases, the NPI decreases.
   - Asymmetric injury can result in asymmetric NPI and can aide with determining the hemisphere injured.
2. A handheld infrared scanner is another emerging technology for non-invasive brain imaging that may be considered to localize superficial intracranial hematomas.[2]

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APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Emergent Resuscitative Thoracotomy (ERT) (CPG ID: 20)

Summarizes recommendations and technique for ERT in a Military Treatment Facility (MTF) in a combat or operational environment. The primary goal is to rapidly identify and correct any life threatening pathology and to provide care that results in a survivor with a meaningful level of function and cognition.

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SUMMARY OF RECOMMENDATIONS & GUIDELINES *

Emergency Resuscitative Thoracotomy (ERT) is a potentially lifesaving intervention for patients who develop or have impending post-injury cardiovascular collapse or full arrest from a potentially reversible cause. While Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) can be considered as an alternative in the absence of thoracic bleeding, there are still several indications for which ERT is a preferred or equivalent option.

The purposes of this procedure are:

- Control of intrathoracic hemorrhage
- Release of cardiac tamponade
- Internal cardiac massage
- Aortic occlusion to control infra-diaphragmatic hemorrhage and maximize cerebral and coronary perfusion.

Consider the following before performing ERT:

1. ERT should only be performed only at a forward military treatment facility with surgical and resuscitation capability (typically Role 2 or higher) and by individuals familiar with and trained in this procedure.
2. Absolute indications for ERT in the combat/operational environment include:
    - Penetrating truncal/extremity trauma with recent loss of vitals (less than 15 minutes) or impending cardiac arrest.
    - Blunt truncal/extremity trauma with pre-hospital vital signs and either witnessed arrest after arrival or refractory shock with impending cardiac arrest.
3. Additional relative indications for ERT in the combat/operational environment include:
    - Penetrating or blunt truncal/extremity trauma with pre-hospital arrest but with signs of life on arrival (narrow complex EKG rhythm and/or organized cardiac contractile activity on ultrasound)
    - Potentially salvageable blunt or penetrating cranial injury with vital signs and then arrest after arrival or impending arrest (uncommon)
4. ERT should NOT be performed for blunt trauma with arrest before arrival and with no signs of life (absent organized narrow complex EKG rhythm and/or organized contractile activity on cardiac ultrasound.)
5. ERT should NOT be performed during multiple or mass casualty (MASCAL) events or when performance will expend critical resources (such as blood products/surgeons/ORs) needed more salvageable patients.
6. The critical steps of an ERT include identification and release of tamponade, control of major thoracic hemorrhage, initiation of open cardiac massage, and cross-clamping the descending aorta.
7. The performance of a simultaneous right anterolateral thoracotomy or extension to a “clamshell” thoracotomy is indicated for evidence of right thoracic or mediastinal injury not reached from the left side.
8. Critical adjuncts to a successful ERT include adequate IV or IO access, endotracheal intubation, initiation of damage control resuscitation, and placement of an oro/naso-gastric tube.
9. For the patient with impending arrest, if immediate or direct transfer to the OR is available then this should be strongly considered versus performing an ERT in the resuscitation area.

10. All necessary equipment/supplies for ERT should be packaged together and stored in an easily accessible location in the resuscitation area, and should be regularly inspected and replaced/replenished as needed.

11. Trauma team training and simulation exercises should be performed at regular intervals and should include review of the necessary equipment, individual tasks, and sequence of events for an ERT

12. All personnel must wear full personal protective equipment and strict attention must be paid to control of needles/sharps to avoid iatrogenic injuries or infectious exposures (needle sticks, cuts, eye splash, etc.).

*These are general guidelines are not intended to replace expert clinical judgment and decisions based on evaluation of an individual patient, local capabilities, and operational considerations.

BACKGROUND

ERT, also called "emergency department thoracotomy," is an extreme procedure, performed in the small subset of patients who arrive either in full post-injury arrest, who rapidly progress to arrest after arrival, or who have impending arrest that precludes immediate transport to an operating room. Exsanguinated patients with profound hypotension or in hemorrhagic shock do not improve with external chest compressions.[1]

The physiologic rationale of ERT is based on both

1. treating several potential sources of bleeding (control cardiac or other intrathoracic bleeding and prevent infra-diaphragmatic exsanguination) and

2. restoring an adequate cardiac output (releasing pericardial tamponade, improving cerebral and coronary perfusion, performing open cardiac massage).

Resuscitative thoracotomy has been extensively described in the civilian trauma literature and has a high mortality rate, largely due to the nature of the injuries leading ERT.[2-5] The survival rates are highest (10 to 30%) for penetrating truncal injuries and patients who arrive with vital signs. They are significantly lower (less than 5%) for blunt trauma victims, particularly those who arrest in the field or during transport (1% or less). In addition, the likelihood of survival with intact neurologic function is significantly lower than the overall survival rates, particularly for blunt trauma victims and for pre-hospital arrest.

In a combat or operational environment, several specific factors must be considered as studies of wartime ERT are available and indicate that there is a reasonable probability of long-term survival and recovery following ERT in appropriately selected casualties.[6-10]

INDICATIONS FOR ERT IN CIVILIAN TRAUMA

In the setting of civilian trauma, ERT is generally indicated only for penetrating trauma with either witnessed cardiac arrest or recent loss of vital signs. These indications were formalized by a working group of the American College of Surgeons Committee on Trauma after collectively reviewing the results of over 4,500 ERT procedures.[3] There was an overall survival rate of only 5% for ERT, although survival was over 30% in patients with low velocity penetrating cardiac injury. When ERT was limited to penetrating trauma and appropriate indications, it is associated with an 8.8% survival rate. Although this remains a very low rate of success, ERT is a true salvage procedure, without which survival is essentially zero even in indicated scenarios. The working group formulated the following recommendations (Class II):

1. ERT is best applied to patients sustaining penetrating cardiac injuries that arrive at trauma centers after a short scene and transport time with witnessed or objectively measured signs of life (pupillary response, spontaneous ventilation, presence of carotid pulse, measurable or palpable blood pressure, extremity movement, or organized cardiac activity).

2. ERT should be performed in patients sustaining penetrating non-cardiac thoracic injuries, but these patients generally experience a low survival rate. Because it is difficult to ascertain whether the injuries are non-cardiac thoracic versus cardiac, ERT can be used to establish the diagnosis.

3. ERT can be performed in patients sustaining exsanguinating abdominal vascular injuries, but these patients generally experience a low survival rate. Judicious selection of patients should be exercised. REBOA may be an equally appropriate salvage procedure. This procedure should be used as an adjunct to definitive repair of the abdominal-vascular injury.

4. ERT should rarely be performed in patients sustaining cardiopulmonary arrest secondary to blunt trauma because of its very low survival rate and poor neurologic outcomes. It should be limited to those that arrive with vital signs at the trauma center and experience a witnessed cardiopulmonary arrest.

The Western Trauma Association (WTA) algorithm recommends ERT for patients with prehospital arrest and CPR duration of less than 10 minutes for blunt trauma and less than 15 minutes for penetrating injury.[5-11] ERT is also recommended for patients undergoing CPR with signs of life (respiratory or motor effort, organized cardiac activity, or pupillary reflexes) or with profound shock (systolic pressure < 60 mmHg). WTA's recommendation for ERT in blunt trauma patients with prehospital arrest and CPR<10 minutes is more liberal than others who recommend against ERT in this cohort; it is noteworthy, however, that this is based on only 5 patients (4 who arrived with organized electrical activity and 1 with tamponade from an atrial laceration).

Most recently, the Eastern Association for the Surgery of Trauma (EAST) Practical Management Guidelines for ERT analyzed 72 relevant studies utilizing the GRADE methodology for assessing the strength of the evidence, but also taking likely patient preferences into account.[12] They defined "signs of life (SOL)" as presence of any of the following: pupillary reactivity, spontaneous breathing, palpable carotid pulse, measurable blood pressure, motor movement, or organized electrical activity. They identified 6 pre-defined patient categories depending of 3 conditions (penetrating or blunt mechanism, thoracic or extra-thoracic location and presence of SOL), and made either strong or conditional recommendations for ERT in pulseless patients, as following:

1. Penetrating thoracic trauma with signs of life but pulseless on arrival (Strong).

2. Penetrating thoracic trauma without signs of life and pulseless on arrival (Conditional).

3. Penetrating extra-thoracic (non-cranial) trauma with signs of life but pulseless on arrival (Conditional).

4. Penetrating extra-thoracic (non-cranial) trauma without signs of life, pulseless on arrival (Conditional).

5. Blunt injury with signs of life but pulseless on arrival (Conditional).

6. For the sixth category of blunt trauma patients without signs of life and pulseless on arrival they gave a conditional recommendation against proceeding with ERT.

Results from prehospital thoracotomy has been reported by a few authors.[13,14] These studies concerned only the subgroup of stab wounds to the chest and described a 10 to 18% survival rate. This experience remains strictly limited to very few experienced teams acting within a trauma system with well-established training and quality assurance.

Recently, the prospective observational multicenter Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery study reported the outcomes of 310 patients undergoing ERT from 2013 to 2017 after either blunt or

penetrating trauma.[15] Survival rate was 12.3% beyond 24h and 5.2% to discharge. The authors discuss the fact that neither practice nor outcomes following ERT have changed in the last 40 years.

REBOA

Recently, the technique of REBOA has emerged in the setting of trauma for control of abdominal and pelvic hemorrhage. Although not strictly comparable, REBOA is a potential alternative to ERT to achieve aortic occlusion and, therefore, control of abdominal and pelvic hemorrhage. Several recent studies tried to compare REBOA and ERT in non-compressible torso hemorrhage[16-18,] and a meta-analysis is available.[19] Even if REBOA seemed to be associated with a lower mortality, there was no significant difference in survival after risk-adjustment, mostly because ERT patients were more critically ill on presentation. This suggests that REBOA is not a comparable intervention to ERT but rather may be utilized to prevent hemodynamic collapse in non-agonal unstable patients. Ongoing study is required to better illuminate the evolving role of REBOA as a potential replacement or as a preemptive adjunct to obviate ERT. Please refer to the JTS REBOA CPG for indications and details of this procedure.[20]

ERT FOR COMBAT CASUALTIES

SPECIFIC CONSIDERATIONS

In the battlefield or operational environment, several important additional factors must be considered. First and foremost is the major difference in the epidemiology of the injured patients presenting to military facility with surgical capabilities. Unlike civilian trauma victims, these patients will generally be younger and healthier and will largely have suffered penetrating or combined blast/penetrating type mechanisms.

Additionally, in combat or austere conditions, the local tactical environment and the impact thereof on critical resources may supersede clinical factors. ERT is a resource-intensive procedure that requires multiple personnel, specialized equipment, supplies, and potentially consumable resources (e.g., blood products- see below). Considering the low overall yield of ERT, the decision to proceed must be based not only on the individual patient factors, but also with consideration of the impact of the procedure on the MTF's overall capabilities. This issue is particularly critical at Role 2 facilities with significantly less personnel, equipment, and surge capacity compared to the more robust Role 3 and higher facilities. ERT should NOT be performed during MASCAL events or multiple casualty events where it would adversely impact the care of others with more survivable injuries.

Notably, careful attention must be paid to the impact of ERT on the local supply of blood products, with immediate early termination of aggressive blood product resuscitation if there is not a prompt response and return of circulation. Termination of efforts should also be considered in the patient with return of vital signs but ongoing major hemorrhage that will exhaust the local blood product supply and an overall low estimated probability of survival.

Pre-hospital thoracotomy on military patients is likely to require complex intervention in very challenging environments. Moreover, the evidence does not support the notion that earlier thoracotomy could improve survival.[21] ERT should only be performed in a setting and facility that has the capability and resources to provide the required level of care in the event of achieving return of circulation or stabilization of impending arrest. This generally limits this procedure to forward MTFs with surgical capabilities, proper equipment, and an adequate supply of blood products.

AVAILABLE LITERATURE

A study based on four-year data from a Role 3 facility in Iraq examined outcomes after ERT in the context of combat trauma.[8] ERT was successful in restoring a perfusing rhythm in half of patients, with 46% survival to the operating room. Although only 12% of patients survived through evacuation from the facility, all survivors were reported to have good functional outcomes. All survivors were reported to be neurologically intact, and there was no difference in survival based on injury mechanism, location or injury pattern. Explosive injury and gunshot wounds were the primary mechanisms of injury for patients in this series. This case series suggests similar or better survival after combat trauma ERT compared with civilian results of ERT. In a previous study limited to wartime penetrating thoracic trauma with cardiac injuries, among 17 patients undergoing ERT, a 24% survival rate was reported.[22]

These results were confirmed in a more recent study examining outcomes among 65 patients who underwent ERT at a single Role 3 facility in Afghanistan.[9] The mechanisms were again all blast and gunshot wounds, and the overall survival rate was 22%. Although there were no survivors among patients with traumatic arrest in the field, there was a 10% 30-day survival among patients who had vital signs in the field and subsequently arrested during transport and 42% for those who arrested after arrival at the MTF. This study also demonstrates the critical aspect of time from arrest to ERT, with survivors having an average time of 6 minutes versus 18 minutes for non-survivors.

A recent retrospective 8-year study of Operations Enduring and Iraqi Freedom resuscitative thoracotomies showed a 9.9% survival rate among 81 patients.[10] Survivors had significantly higher extremity Abbreviated Injury Scale, (suggesting the usefulness of aortic occlusion in penetrating pelvic or junctional exsanguination), higher initial oxygen saturation, and higher post-procedural blood product and volume resuscitation (possible survival bias). Although not statistically significant, all survivors also had an explosive/blast mechanism. This work suggests that ERT may improve the outcomes in primary extremity blast injuries who were in extremis at arrival.

RECOMMENDATIONS

A recommended algorithm for ERT in traumatic arrest in the combat or operational environment is presented in Appendix A.

PENETRATING INJURIES

- Resuscitative thoracotomy at an MTF in the combat or operational environment is most strongly indicated and warranted in patients with penetrating injuries who present to an MTF in extremis or with a recent witnessed loss of vital signs, especially those with penetrating thoracic injuries. Although there is controversy on the exact definition of “recent” loss of vital signs, the majority of data supports up to 10-15 minutes as a cutoff for pre-hospital arrest with penetrating truncal or extremity trauma.
- Though most of these casualties will not survive, up to 25% of penetrating trauma patients who undergo ERT at a forward military facility can be salvaged with acceptable neurological outcomes.

BLUNT TRAUMA

- In the deployed setting, victims of blunt trauma are less common but most commonly present after vehicle crashes or falls from height. The previously noted study from a combat trauma setting found no ERT survivors after blunt injury, although the blunt cohort was small.
- In the operational setting, ERT for blunt trauma should be based upon clinical judgment, recognizing that the data from civilian studies has demonstrated a very low survival rate. It should be limited to those who have either witnessed in-hospital arrest, pending arrest, or those with definite vital signs in

the field and who arrive with clear and present signs of life (organized narrow complex EKG and/or organized cardiac contractile activity on bedside cardiac ultrasound).

- Blunt trauma patients with no vital signs at the scene of injury and during transport, or with reported vital signs during transport but who arrive in arrest should NOT have ERT performed.

SPECIAL CIRCUMSTANCES

- Patients with injuries that have a low likelihood of salvage, such as traumatic brain injury or high total body surface area burns, should be either declared expectant on arrival or at most managed with non-operative resuscitation and interventions (intubation, chest tubes, fluid/blood resuscitation) and then reassessed.
- In patients with arrest or impending arrest with severe blunt or penetrating traumatic brain injury, ERT is generally contraindicated unless there is evidence of preserved neurologic function and a potentially salvageable and survivable brain injury.

REBOA to control life-threatening sub-diaphragmatic hemorrhage in surgically capable theater facilities may be a selective alternative to ERT, as detailed in the JTS REBOA CPG.[20]

TECHNIQUE

The objectives of the ERT are always the same, no matter the injuries: to stop the bleeding and restore adequate central perfusion. Immediate attention should be paid to the most lethal potential findings, such as cardiac tamponade, penetrating cardiac injury, great vessel injury, and massive pulmonary injury. In the event that the injury is on the right side of the heart or chest, the standard ERT incision may be extended to the bilateral thoracotomy or "clamshell" incision with extension across the sternum. ERT is a well-codified procedure that can be considered in several steps:

1. Left anterior-lateral thoracotomy incision
2. Opening the pericardium
3. Control of a cardiac injury
4. Temporary control of active lung bleeding
5. Cross-clamping of the descending aorta
6. Internal cardiac massage and defibrillation
7. Repair of other thoracic, abdominal or peripheral injuries

Concurrent massive transfusion protocol, as well as potential pharmacological adjuncts, is essential. Rapid successful restoration of cardiac function is the key to deciding on the relevance of continuing the procedure.

The detailed technical steps are presented in detail in Appendix B.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Patients with AIS chest, abdomen, pelvis, and/or lower limb ≥3 with SBP >0 and <90 or CPR in progress on arrival to first MTF AND not isolated head injury (AIS head/face/neck = 5 or 6).

INTENT (EXPECTED OUTCOMES)

ERT is not performed in patients with no signs of life or CPR >15 minutes or isolated severe TBI.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients who underwent ERT (or REBOA) in the population of interest.
2. Number and percentage of patients who did not undergo ERT (or REBOA) in the population of interest.
3. Number and percentage of patients who underwent ERT who survived 24 hrs, 7 days, 30 days (assume alive if discharged alive prior to each time point).
4. Number and percentage of patients who did not undergo ERT (or REBOA) in the population of interest who were declared KIA/DOA or who survived 24 hrs, 7 days, 30 days (assume alive if discharged alive prior to each time point).

DATA SOURCES

- Patient Record.
- Department of Defense Trauma Registry (DoDTR)
- Morbidity and Mortality Conference Reports

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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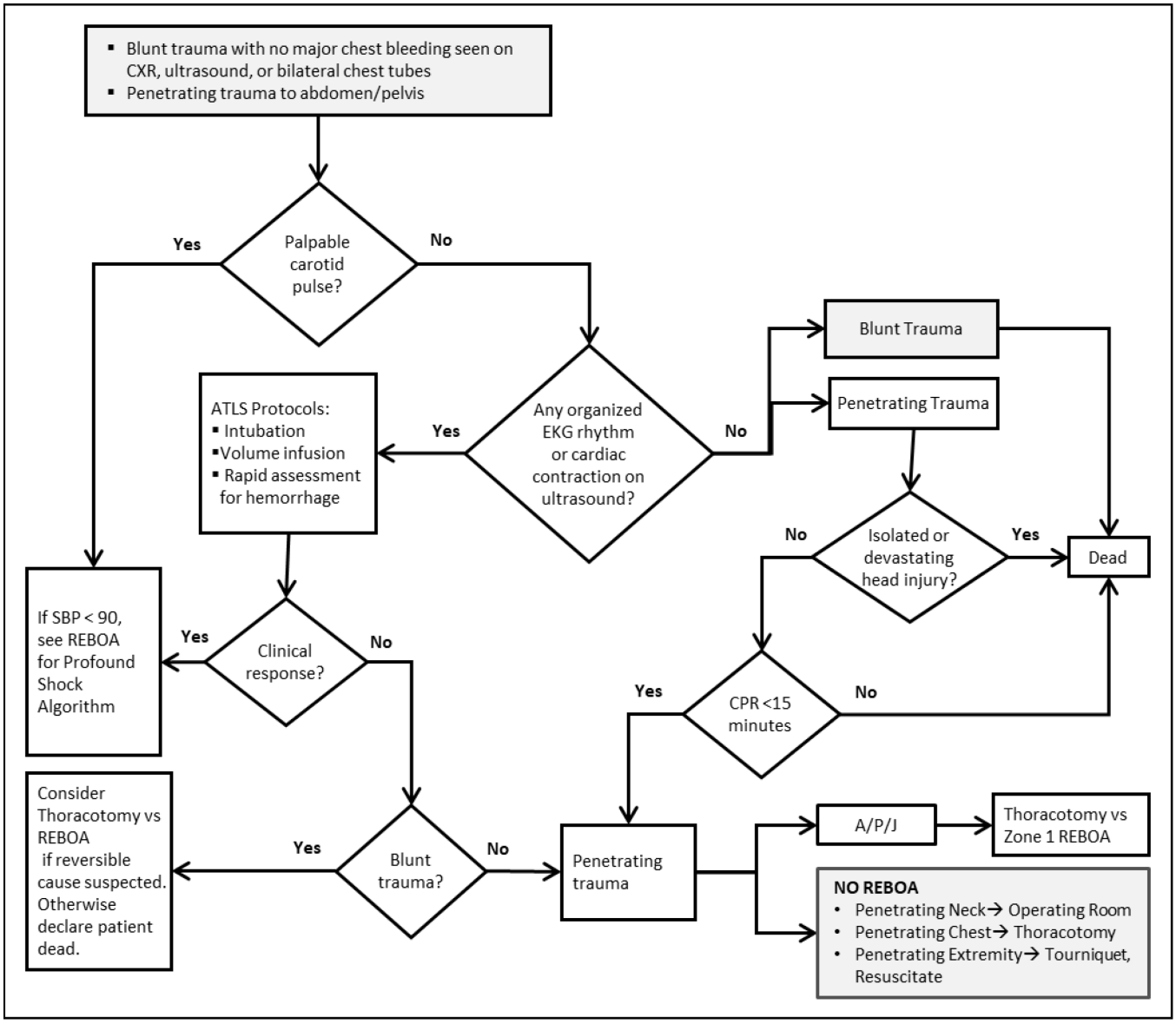
APPENDIX A: RECOMMENDED ALGORITHM FOR ERT IN TRAUMATIC ARREST



APPENDIX B: TECHNIQUE OF EMERGENCY RESUSCITATIVE THORACOTOMY

PREPARATION

All emergency and surgical personnel at a Role 2 or higher facility should be trained in their roles and actions to facilitate performance of an ERT.

All needed supplies and equipment for an ERT should be pre-packaged and stored in a readily accessible location in the resuscitation area, and periodically inspected for completeness and service ability.[23]

The surgeon and designated team members should review the contents and composition of the ERT supply package.

All personnel performing, assisting, or otherwise participating in an ERT should be wearing full personal protective equipment including a gown, gloves, and eye protection.

The urgency of the procedure, coupled with the mix of multiple assistants and multiple potential sharps represent a high-risk scenario for accidental injuries and infectious disease exposure to the involved medical personnel (See JTS Infection Prevention in Combat-Related Injuries CPG.[24] Great care must be taken during training and actual ERT procedures to highlight safety precautions including control of all needles, syringes, scalpels, and other sharps.

Sterile preparation is not required for ERT, as the nature of this procedure does not afford the time for prep solutions to dry and assume their antimicrobial efficacy.

If at all possible, definitive airway control should be obtained prior to or during ERT, but ERT should not be delayed solely to establish a secure airway.

Efforts to obtain adequate intravenous or intraosseous access for blood product infusion should proceed simultaneous to ERT, keeping in mind that in the case of penetrating thoracic trauma, infusions via the upper extremities may be ineffective until bleeding is controlled. Similarly, lower extremity, pelvic, or abdominal wounds with exsanguination should be resuscitated via an upper extremity or central venous catheter. In the patient with difficult intravenous access, intraosseous access should be immediately established, preferably in the sternum or humerus.

Placement of a right chest tube if there is any possibility of injury/hemorrhage on the right side should be strongly considered. Alternatively, the right chest may be open through an extended thoracotomy or clamshell incision.

Effective suction should be available for successful ERT.

INCISION AND EXPOSITION

1. ERT begins with a generous curvilinear left anterolateral thoracotomy (from the sternum to the table) at approximately the fourth intercostal space. If previously performed, a tube thoracostomy incision can serve as a starting point for the thoracotomy. Exposure can be significantly improved by placing a towel or roll under the left back to elevate and rotate the left chest.

2. The nipple line in males and the inframammary crease in females is a reasonable anatomic landmark (time should not be spent attempting to count ribs). If in doubt, it is best to err more superiorly rather than make too low an incision.

3. After the initial incision with a knife to/through the level of the chest wall muscles, heavy scissors may be used to rapidly and safely open the remaining tissues through the full extent of the incision by sliding the partially opened scissors along the superior rib border.

4. The internal mammary vascular pedicle is located 1-2cm lateral to the sternal border and will be transected during ERT. Transection of these vessels is of no physiologic consequence, but control of associated bleeding (only after return of circulation in case of successful procedure) with suture or clips will be necessary.

5. If after initial left ERT, additional right-sided thoracic, cardiac or pulmonary hilar exposure is needed, the incision should rapidly be extended across the sternum (with a Lebsche knife or simple trauma shears) and continued on the right side (bilateral thoraco-sternotomy or "clamshell" incision).

6. Once the incision is completed, a rib retractor is placed (with the handle downward), the ribs are spread and the lung is initially packed posteriorly with laparotomy pads or sterile towels, or manually retracted by an assistant; this can be facilitated by incision of the inferior pulmonary ligament. After evacuating blood and/or formed clot from the left pleural space, the pericardium is visualized to assess for cardiac activity and for hemopericardium.

   NOTE: One of the most common technical errors in ERT is poor exposure due to inadequate length of the skin incision and lack of complete division of the subcutaneous and muscle layers.

CARDIAC PROCEDURES

1. Pericardotomy: The pericardium is opened longitudinally at least one finger breadth anterior to the phrenic nerve which can be identified in its cranio-caudal course along the lateral pericardium, generally within 1-2cm of the pulmonary hilum. The pericardium should be opened by grasping with a forceps and using a tissue scissor, followed by extension down to the diaphragm and cephalad to below the thoracic inlet. In cases with a large hemopericardium, tension may make grasping the pericardium with forceps difficult. The heart can then be delivered partially out of the pericardium to inspect for injury and facilitate open cardiac massage if needed.

2. If after pericardiotomy, a cardiac injury is identified, initial temporary control may be achievable with digital pressure, a large side-biting clamp, a Foley catheter, or even a surgical skin stapler.

3. In the absence of effective cardiac activity, open cardiac massage should be rapidly instituted at this point using a two-handed technique, which is less traumatic and produces a better cardiac output. This will be ineffective unless concurrent volume resuscitation has occurred sufficient to provide adequate preload.

4. Defibrillation must be early attempted in cardiac arrest. If internal paddles are available, an electric shock is typically delivered at 20 Joules. If not, external paddles can also be used in the usual cutaneous position at 200 J, after temporarily removing the costal retractor so as to briefly close the chest cavity.

5. If there is no cardiac injury and no cardiac activity (asystole), resuscitative efforts should be terminated after a reasonable time (5-10 minutes).

6. In case of successful restoration of cardiac activity, cardiac or other intrathoracic injuries should be more definitively repaired, and exploration completed.

AORTIC CROSS-CLAMPING

1. If there is known or suspected hemorrhage from below the diaphragm, initial attention after thoracotomy should be focused on clamping the descending thoracic aorta. The lung is retracted and packed anteriorly and superiorly to identify the aorta in its location just anterior to the vertebrae. This can be facilitated by incising the inferior pulmonary ligament.

2. The aorta should be clamped just above the diaphragm to maximize collateral flow and spinal cord perfusion. In exsanguinated or asystolic patients (i.e. with a "flat" aorta"), the esophagus is easily mistaken for the aorta. Placing an orogastric or nasogastric tube will help identify and avoid injury to the adjacent esophagus (located just medial/anterior to the aorta).

3. Opening the mediastinal pleura, limited blunt dissection is used on either side of the aorta to facilitate the placement of a large, atraumatic DeBakey vascular clamp.

4. After the clamp is placed, aggressive resuscitation may be instituted and immediate plans made for direct surgical control of the patient's injuries. If a patient remains severely hypotensive despite fluid resuscitation after aortic clamping, it is unlikely that he has a survivable injury.

5. The duration of intra-thoracic aortic cross clamp should be carefully monitored, and the maximum tolerated duration in the patient already in hemorrhagic shock is 30-40 minutes. It should be removed at the earliest possible time, or the level of cross clamp could be moved inferiorly to the abdominal aorta or iliac vessels if proximal control of abdominal, pelvic, or extremity vascular injuries is still required. Once the injury is addressed, as the clamp is removed, the team should be prepared for rapid hemodynamic shifts and the potential development of hyperkalemia and/or metabolic acidosis (ischaemia-reperfusion injury or "reperfusion syndrome.").

INJURY WITHIN THE THORAX

If after thoracotomy, there is a direct injury to the lung or hilar vessels, direct pressure (with a finger, rolled gauze, or laparotomy sponge) is generally sufficient for temporary control of bleeding in this low pressure system. Using lap pads to collapse the lung parenchyma medially will pack the hilum and free up your hands initially to allow a more detail inspection of the chest, heart, and vessels for sites of hemorrhage, and allow the placement of the aortic clamp. Some major pulmonary injuries might need early hilar cross-clamping en masse.

Once temporary control is in place, resuscitation can be instituted and the patient may be taken to the operating theatre for definitive lung repair with stapled resection, suture repair, stapled "tractotomy," or in extreme cases pneumonectomy (which carries a very high mortality in the trauma setting, even in the absence of pre-procedural arrest).

Large pulmonary injuries also create a risk for air embolism which can result in entrained air entering the pulmonary veins and subsequently the left heart and coronary vessels. Early pulmonary hilar clamping, rapid direct control of lung lacerations or temporarily submerging the area in irrigation fluid can help prevent this risk.

If there is a thoracic great vessel injury, temporary control may be achievable with digital pressure or atraumatic vascular clamps. If these are insufficient to control a great vessel injury in the setting of an ERT, this likely represents a non-survivable injury.

Unlike pulmonary bleeding, intercostal and chest wall bleeding is under arterial pressure and will require more focal and firm pressure for initial control, followed by mass suture ligatures and/or clip

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Eye Trauma: Initial Care (CPG ID:03)

This CPG provides a step-by-step approach for the non-ophthalmologist in the initial evaluation and treatment of eye trauma injuries sustained in the combat theater or in remote and austere environments.

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Rapid Update (Jun 2023): removal of Promethazine recommendation in accordance with DHA Policy Memo 23-001 Discontinuation of Injectable Promethazine Usage at MTFs.

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SUMMARY OF CHANGES

- Antibiotics for open globe and intraocular foreign body (IOFB)
- Aeromedical evacuation considerations
- Lateral canthotomy, inferior cantholysis technique with instructional pictures

BACKGROUND / EXECUTIVE SUMMARY

- Eye injuries are common in warfare.[1-3] During Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) 10-15% of combat-related trauma injuries involved the eye. [4]
- Significant numbers of potentially serious eye conditions can arise in non-battle environments and during non-battle activities.[1]
- A large percentage of serious and/or blinding eye injuries can be prevented by wearing approved combat eye protection[4] from the Authorized Protective Eyewear List (APEL) available at https://www.peosoldier.army.mil/equipment/eyewear/.
- The eye is extremely intolerant of injury.
  - Eye trauma requires prompt evaluation and treatment by an eye surgeon.
  - The foundation for successful treatment and preservation of vision is most often laid in the **initial phases** by forward medical providers at all echelons of care.
- Ophthalmic resources are deployed increasingly sparingly in very select locations.
  1. Initiate teleophthalmology consultation with eye surgeon as soon as possible. (See Teleophthalmology.)
  2. Evacuate all vision-threatening injuries so that they receive treatment by an eye surgeon within 24 hours, if possible.
     - Factors such as combat operations, aircraft availability, weather, proximity to port, transport safety and security can affect the timing of transfer and definitive treatment.
     - When evacuation to an eye surgeon is delayed or caring for ocular injuries in the Prolonged Field Care Environment, see the *Joint Trauma System Ocular Injuries and Vision-Threatening Conditions in Prolonged Field Care Clinical Practice Guideline, 01 Dec 2017*.

GOALS OF EYE TRAUMA CARE

PRIORITIES

Maintain high index of suspicion based upon the mechanism of injury.

Eye Exam

- When possible, assess and document, at a minimum, visual acuity.
- Examine for critical findings. (See below.)

Management

1. Recognize and immediately treat the two traumatic eye emergencies listed below:
   a. For chemical injury, ***irrigate immediately and copiously***. (See Chemical Injury.)
   b. For orbital compartment syndrome, perform immediate lateral canthotomy and inferior cantholysis. (See Orbital Compartment Syndrome.)
2. **SHIELD AND SHIP** vision-threatening eye injuries:
   a. Protect injured eyes (known or potential injuries) with a rigid eye shield immediately (i.e. "Eyepro" or "Fox shield").
   b. Maintain patient comfort, treat pain and nausea.
   c. Prevent further damage.
   d. Do **NOT** put pressure on eye with suspected open globe injury.
   e. Initiate teleophthalmology consultation with eye surgeon as soon as possible. (See Teleophthalmology.)
      - Urgent: Call Role 3 or Role 4 with an eye surgeon (ophthalmologist).
      - Non-urgent: Contact Role 3 or Role 4 with an eye surgeon (ophthalmologist). Can use Pacific Asynchronous TeleHealth (PATH)/ Health Experts online Portal (HELP) web-based system if no ophthalmologist in theatre.
   f. Evacuate all vision-threatening injuries so that they are able to receive treatment by an eye surgeon within 24 hours when possible.

Prevent Eye Injuries

1. Encourage wearing only approved eye protection in accordance with unit guidelines and requirements. Examples: Military Combat Eye Protection (MCEP), Ballistic Protective Eyewear (BPE), "eyepro," or "eye armor." (See Protective Eyewear.)
2. Discourage contact lens use.

EYE HISTORY

"Keep an eye out" for eye trauma.

1. Maintain high index of suspicion based upon mechanism of injury.
   - Blast injury - most common cause eye injury in OIF and OEF.[5,6]
   - Direct facial and eye trauma.
   - Cranial or brain injury.[5,7]

- Metal on metal mechanisms (metallic fragments can penetrate without obvious signs on exam).
- Compressive blunt force trauma (can cause ruptured globe).
- Multisystem trauma. It is easy to overlook ocular trauma.
- Unconscious patient who cannot report vision change.
- Thermal burns, especially to the face.

2. If patient can follow commands, ask about eye symptoms such as vision loss, decreased vision, double vision, or eye pain.
3. Ask if casualty was wearing MCEP, BPE, "Eyepro," or "eye armor" at time of injury. Review past eye history, including use of glasses or contact lens.
4. Review tetanus status.

INITIAL EYE EXAM[8]

VISION

1. Assess and document visual acuity for each eye if possible. (See Visual Acuity Testing.)[8]
2. Presenting vision may be the best predictor of final visual outcome.[9]

INTRAOCULAR PRESSURE (IOP)

1. Do NOT put pressure on eye with suspected open globe injury.
2. If orbital compartment syndrome is suspected, palpate eyelids to see if one eye has increased firmness and resistance compared with the opposite eye ("rock hard" eyelids).
3. Do not attempt to check IOP at Role 1 or 2 unless experienced with this technique.

PUPILS

Test for relative afferent pupillary defect (RAPD) using swinging flashlight test. (See RAPD Testing.)

EXTRAOCULAR MOTILITY

If patient can follow commands, ask to follow your finger without moving the head. Record any restrictions to movement.

EXAMINATION

Examine for critical findings. Perform focused eye exam "outside to inside."

- External Exam – face, bony orbit, eyelids.
- Eye – conjunctiva, cornea, anterior chamber, iris, lens. (See Eye Anatomy.)
- Unless experienced, do not attempt fundus/posterior segment examination at Role 1 or 2.

- Do NOT attempt ultrasound of the injured eye because it places pressure on the eye.

SHIELD AND SHIP

SHIELD AND SHIP vision-threatening eye injuries [10-11]

1. Protect injured eyes (known or potential) with a rigid eye shield immediately - Eyepro or Fox shield. (See How to Place Eye Shield.)
   a. Base protection choice upon findings of eye history and exam.
   b. Treat eyelid injuries like an open globe.
2. Maintain patient comfort during transport.
   a. Prevent Valsalva which can increase the risk of extrusion of intraocular contents.
   b. Provide pain control and sedation as needed.
   c. Treat nausea and vomiting aggressively (Ondansetron 4-8 mg IV).
   d. Avoid strenuous movements.
   e. Bed rest with head elevated 30 degrees if possible.
3. Prevent further damage. **Do no harm.** (See Do No Harm Section below.)
   Do NOT put pressure on eye with suspected open globe injury.
4. Initiate teleophthalmology consultation with eye surgeon as soon as possible.
   (See Teleophthalmology.) Provide focal history, exam, and photographs when able.
5. Evacuate all vision-threatening injuries so that they are able to receive treatment by an eye surgeon within 24 hours if possible.
   a. Teleophthalmology consultation with an ophthalmologist is recommended before fixed wing transport (see Aeromedical Transport Considerations).
   b. When in doubt: SHIELD AND SHIP.

DO NO HARM (DO NOT'S)

1. DO NOT let a suspected eye injury leave your level of care without rigid eye protection.
2. DO NOT patch. It puts pressure on eye. **(*DO shield but DO NOT patch.)***
3. Do NOT wrap. It puts pressure on eye.
4. Do NOT place anything under an eye shield, including gauze.
5. DO NOT put pressure on eye with suspected open globe injury; it may increase the risk of extrusion of intraocular contents.
6. DO NOT check intraocular pressure at a Role 1 or 2. (Eye surgeon will check at Role 3 or 4.)
7. Do NOT attempt ultrasound of the eye. It places pressure on the eye.
8. DO NOT remove impaled or resistant foreign bodies.
9. DO NOT attempt to repair eye.

10. DO NOT enucleate or debride tissue, even if eye is severely traumatized.

TELEOPHTHALMOLOGY [12]

1. Management of eye injuries is complex. Recommendation is to engage an eye surgeon via teleophthalmology consultation as soon as possible.
2. Teleophthalmology improves and extends ophthalmic care to remote deployed locations.
   - **Urgent:** Use phone or video teleconference service to call a Role 3 or Role 4 with an eye surgeon (ophthalmologist).
   - **Non-urgent:** Contact Role 3 or Role 4 with an eye surgeon (ophthalmologist). Can use Pacific Asynchronous TeleHealth (PATH)/Health Experts online Portal (HELP) web-based system if no ophthalmologist in theatre.
3. Information to provide in consult:
   a. Focal history: Mechanism of injury, history of eyepro use, use of glasses or contact lenses
   b. Focal exam: Visual acuity, key exam findings
   c. Photograph(s)

PREVENTION

1. Encourage wearing only approved eye protection with MCEP, BPE, "eyepro," or "eye armor" (protective eyewear per Unit guidelines).
2. Discourage contact lens use.

Figures 1 & 2. Eye armor will help prevent many, but not all, eye injuries. If any kind of injury involves any portion of the face that would otherwise be covered by protective spectacles or goggles, maintain high level of suspicion – regardless of obvious severity.

Figure 1. Eye protection worked after vehicle hit by rocket-propelled grenade.
Photo credit: COL Darrel K. Carlton

Figure 2. Maintain high index of suspicion for eye trauma injury even if not obvious.
Photo credit: COL (Ret) Thomas H. Mader, MD.

OPEN GLOBE INJURY

MECHANISM

- Laceration(s) from penetrating or perforating trauma. [13]
- Ruptured globe from blunt trauma.

EXAM FINDINGS

- Collapsed or severely distorted eye.
- Open wound, full-thickness corneal or scleral laceration.
- Shallow anterior chamber.
- Peaked or irregular pupil.
- Prolapse of intraocular contents outside the eye. Dark tissue is iris or uveal tissue.
- Subconjunctival hemorrhage (SCH), especially if 360 degrees.

MANAGEMENT [14-19]

1. Assess and document vision when possible.
2. Early teleophthalmology consultation with eye surgeon (See Teleophthalmology).
3. SHIELD AND SHIP
   a. Rigid eye shield immediately.
   b. Evacuation for urgent surgical repair within 24 hours when possible. [18,20-25]
4. Nothing to eat or drink.
5. Bed rest with head elevated 30 degrees if possible.
6. Avoid maneuvers that increase intraocular pressure.
7. Start systemic antibiotics. [14,26-34]
   a. Levofloxacin 750 mg IV/PO q24hrs PLUS Vancomycin 15-20mg/kg IV q8-12hrs OR
   b. Moxifloxacin 400 mg IV/PO q24hrs
   c. Preferred regimen for prophylaxis is levofloxacin plus vancomycin or moxifloxacin alone based on limited data, expert opinion, and spectrum of antibiotic activity; this provides coverage for *B. cereus*, gram negative organisms including *Pseudomonas aeruginosa*, and drug resistant gram positive organism such as MRSA. Note that vancomycin penetration into vitreous is limited in a healthy eye; weight based dosing may improve levels. Levofloxacin and moxifloxacin have excellent penetration. Levofloxacin has superior gram negative coverage and moxifloxacin has greater gram positive coverage. Either drug, when used alone, do not have reliable MRSA coverage.
8. Treat nausea and vomiting aggressively (Ondansetron 4-8 mg IV).
9. Administer tetanus prophylaxis per Infection Prevention in Combat-Related Injuries CPG.

10. Provide sedation and analgesia as needed (maintain patient comfort).
11. DO NOT put pressure on eye. It may increase the risk of extrusion of intraocular contents.
12. Do NOT attempt ultrasound of the eye. It places pressure on the eye.
13. Do NOT attempt to repair.
14. Do NOT attempt to enucleate eye.
15. Do NOT attempt to debride tissue, even if the eye is severely traumatized.

Figures: Open globe.

Figure 3. Open globe with eyelid laceration secondary to rubber pellets from nonlethal grenade explosion.
Photo credit: LTC Won Kim.

Figure 4. Corneal laceration and eyelid laceration.
Photo credit: COL Mark Reynolds.

Figure 5. Open globe with peaked pupil and iris prolapse.
Photo credit: Maj Brett Davies.

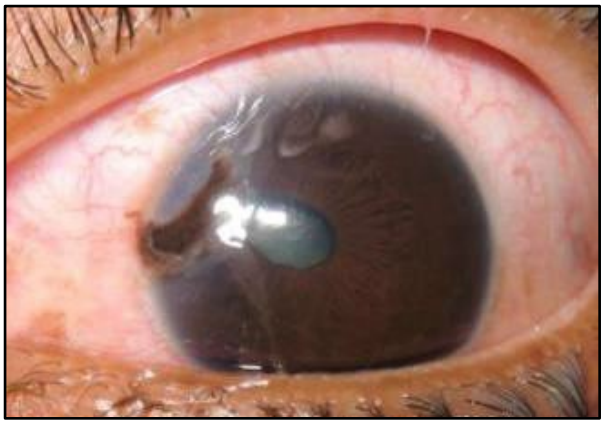


Figure 6. Open globe with eyelid laceration secondary to rollover motor vehicle crash.
Photo credit: CDR Eva Chou.

IOFB INJURY

HISTORY

High index of suspicion if blast injury, shrapnel, or metal-on-metal injury.

EXAM

- Penetrating or perforating site(s) sclera or cornea.
- Hole in iris.
- Findings may be subtle; maintain high index of suspicion

MANAGEMENT [37,38]

1. Assess and document vision if possible.
2. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
3. SHIELD AND SHIP
    a. Apply rigid eye shield immediately.
    b. Evacuate for urgent surgical repair within 24 hours if possible. [38-44]
4. Nothing to eat or drink.
5. Bed rest with head elevated 30 degrees if possible.
6. Avoid maneuvers that increase intraocular pressure.
7. Start systemic antibiotics. [38,40]
    a. Levofloxacin 750 mg IV/PO q24hrs PLUS Vancomycin 15-20mg/kg IV q8-12hrs OR
    b. Moxifloxacin 400 mg IV/PO q24hrs
    c. Preferred regimen for prophylaxis is levofloxacin plus vancomycin or moxifloxacin alone based on limited data, expert opinion, and spectrum of antibiotic activity; this provides coverage for *B. cereus*, gram negative organisms including *Pseudomonas aeruginosa*, and drug resistant gram positive organism such as MRSA. Note that vancomycin penetration into vitreous is limited in a healthy eye; weight based dosing may improve levels. Levofloxacin and moxifloxacin have excellent penetration. Levofloxacin has superior gram negative coverage and moxifloxacin has greater gram positive coverage. Either drug, when used alone, do not have reliable MRSA coverage.
8. Treat nausea and vomiting aggressively (Ondansetron 4-8 mg IV).
9. Administer tetanus prophylaxis per Infection Prevention in Combat-Related Injuries CPG.
10. Provide sedation and analgesia as needed.
11. ***Do not attempt to remove IOFB***.
12. ***Do not put pressure on eye***, it may increase the risk of extrusion of intraocular content.

Figures: Intraocular foreign body. Findings may be subtle.

Figure 7. Multiple foreign bodies in the cornea from an IED blast. Some of the foreign bodies penetrated into the eye. Most foreign material was determined to be stone.
Photo credit: CAPT (Ret) Joseph Pasternak, MD.

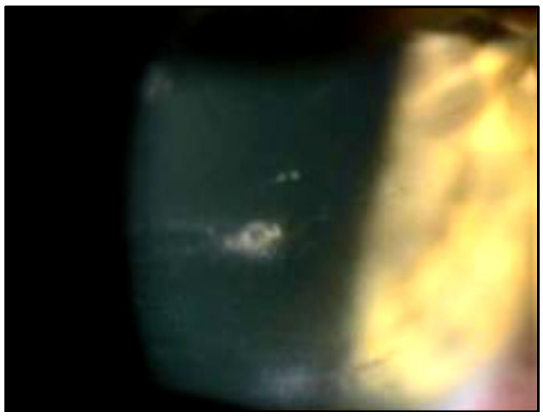
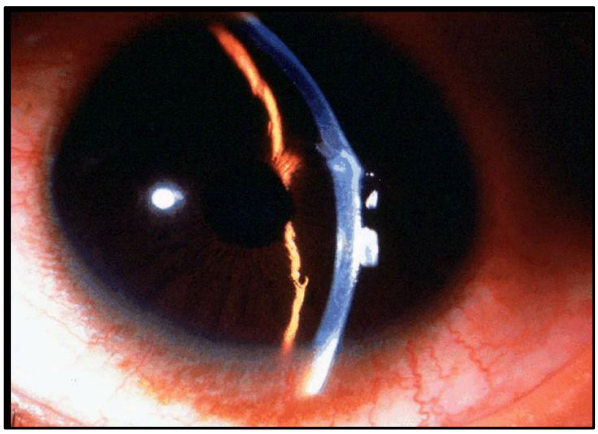


Figure 8. Penetration of concrete foreign body into the eye.
Photo credit: Lt Col Matthew Caldwell.

Figure 9. Same case demonstrating multiple foreign bodies in the cornea. Some foreign bodies penetrated the eye. Maintain a high index of suspicion based upon mechanism of injury.
Photo credit: CAPT (Ret) Joseph Pasternak, MD.

Figure 10. Subtle corneal penetration from foreign body.
Photo credit: CAPT (Ret) Joseph Pasternak, MD.



CHEMICAL INJURY

EXAM

1. Epithelial defect(s) of cornea or conjunctiva
2. Redness and swelling of conjunctiva
3. Blanching of conjunctiva
4. Corneal opacification

MANAGEMENT

1. Begin irrigation immediately.
    - Irrigate with normal saline or lactated Ringer's if available.
    - Acceptable to use water or any neutral irrigation solution (best solution choice is normal saline or lactated Ringer's).
    - Use Morgan Lens (first choice if available) or nasal cannula hooked to IV tubing for continuous irrigation. (See Continuous Irrigation Using Nasal Cannula.)
2. Use a **minimum of 2 liters** irrigation if unable to check PH. Some chemical injuries require up to 10 liters.
3. Apply topical anesthesia with tetracaine, proparacaine or lidocaine as needed to maintain patient comfort during irrigation.
4. Do NOT try to neutralize acid with base or base with acid.
5. Remove visible acidic or basic foreign bodies with a cotton tip applicator (CTA).
6. Remember to inspect the conjunctival fornices for retained foreign bodies. Irrigate or sweep fornices with a CTA.
7. Assess and document vision if possible.
8. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
9. SHIELD AND SHIP.

Figures: Chemical injury.

Figure 11. Alkali burn with corneal opacification and blanching of conjunctiva.
Photo credit: Wills Eye Manual 7th Edition.

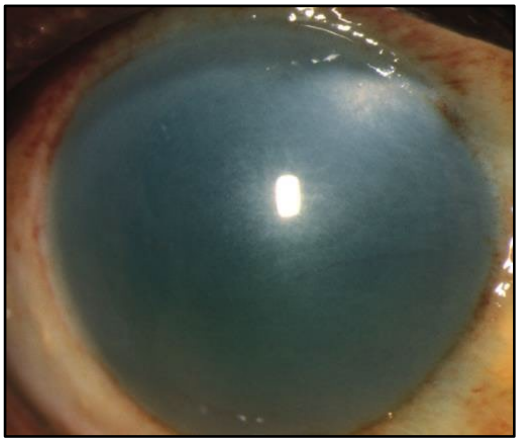


Figure 12. Irrigation. Using bottle of normal saline to irrigate the eye, patient is instructed to look in various directions while the opposite portions of the conjunctival cul-de-sac are flushed vigorously.
Photo credit: 2018 American Academy of Ophthalmology.

ORBITAL COMPARTMENT SYNDROME

HISTORY

Most common cause is **retrobulbar hemorrhage/orbital hemorrhage**.

EXAM

1. Decrease or loss of visual acuity.
2. "Rock hard" eyelids, or eyelids tight against the globe on palpation.
   Palpate eyelids to see if one eye has increased firmness and resistance compared with the opposite eye.
3. Proptosis: bulging of affected eye compared to the other.
4. Relative afferent pupillary defect (RAPD).

MANAGEMENT

1. Emergent lateral canthotomy and inferior cantholysis. (See Lateral Canthotomy.)
2. Assess and document vision if possible.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology).
4. SHIELD AND SHIP.

HYPHEMA [45]

EXAM

- Blood or clot in anterior chamber.
- "8-ball" or "black ball" hyphema is blood filling the anterior chamber.

MANAGEMENT

1. Rule out open globe.[46]
2. Assess and document vision if possible.
3. Determine if the patient has sickle cell disease or trait.
4. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
5. SHIELD AND SHIP.
6. Bed rest with head elevated 30 degrees if possible.

Figure 13. Hyphema. Blood filling anterior chamber.
Photo credit: 2018 American Academy of Ophthalmology.

ORBITAL FRACTURE

EXAM

- Step-off orbital rim.
- Restricted eye movements.
- Enophthalmos (affected eye is further back in orbit compared with other eye).
- Hypoglobus (affected eye is lower compared with other eye).
- Subcutaneous or conjunctival emphysema.
- Numbness below eye.

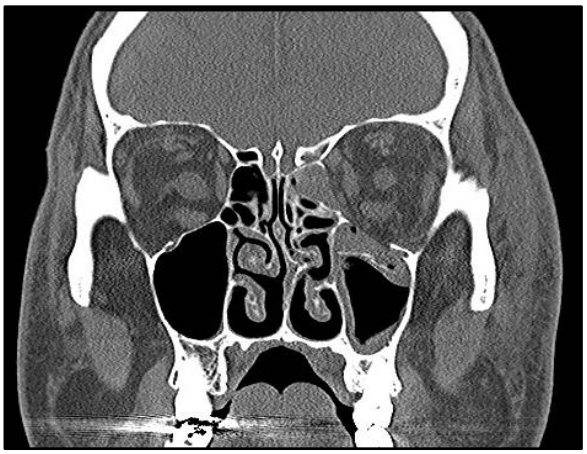
MANAGEMENT

1. Urgent repair required when clinical evidence of extraocular muscle entrapment with nonresolving bradycardia, heart block, nausea, vomiting, or syncope (oculocardiac reflex).
2. Assess and document vision if possible.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology).
4. SHIELD AND SHIP.
5. Consider systemic antibiotics if sinusitis or dirty wound.
6. Avoid Valsalva and maintain sinus precautions (no nose blowing).
7. Maintain high suspicion for open globe.

Figures: Orbital fracture.

Figure 14. Entrapment of left inferior rectus muscle from left orbital floor fracture. Patient is unable to look upward with left eye.
Photo credit: Maj Brett Davies.

Figure 15. Computed tomography showing left orbital floor and medial wall fractures.
Photo credit: Maj Brett Davies.



EYELID LACERATION

EXAM

Note if laceration involves eyelid margin or nasolacrimal system.

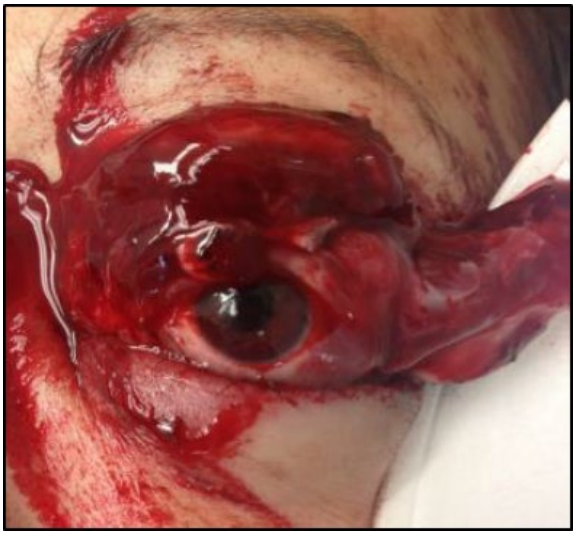
MANAGEMENT

1. Maintain high suspicion for open globe.
2. Assess and document vision if possible.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
4. SHIELD AND SHIP.
5. Unless experienced, delay definitive repair for laceration involving eyelid margin for surgery by ophthalmologist. Do NOT repair in the presence of an open globe injury.
6. Do NOT debride or discard tissue, even if the eye is severely traumatized.

Figures: Eyelid laceration.

Figure 16. Lower eyelid laceration involving nasolacrimal system.
Photo credit: Maj Brett Davies.

Figure 17. Upper eyelid laceration.
Photo credit: Maj Brett Davies.



THERMAL BURN

EXAM

- Facial burn
- Eyelid burn and eyelash loss

MANAGEMENT

1. Assess and document vision if possible.
2. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
3. SHIELD AND SHIP.
4. If unable to close eyelids, start sterile eye ointment to prevent eye exposure.
   a. Give petrolatum or erythromycin ointment if available.
   b. Apply every 2-4 hours to eye surface.
5. Aggressive fluid resuscitation may rarely lead to orbital compartment syndrome requiring lateral canthotomy and inferior cantholysis.

Figure 18. Eye and facial thermal burn. Eye ointment on ocular surface.
Photo credit: Maj Brett Davies.

CORNEAL ABRASION

EXAM

- Epithelial defect.
- NO infiltrate (whitish opacity in cornea). Infiltrates indicate infection or inflammation of cornea.
- Stains with fluorescein when illuminated with cobalt blue light if available.

MANAGEMENT

1. Ophthalmic antibiotic ointment or drops.
    a. Erythromycin, bacitracin, or bacitracin/polymyxin one ribbon every 2-4 hours if available OR
    b. Fluoroquinolone (e.g., moxifloxacin, gatifloxacin, levofloxacin) OR polymyxin B/trimethoprim instill one drop 4 times daily if available.
2. Stop contact lens wear.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)

Figures: Corneal abrasion.

Figure 19. Epithelial defect with NO infiltrate.
Photo credit: CAPT (Ret) Joseph Pasternak, MD.

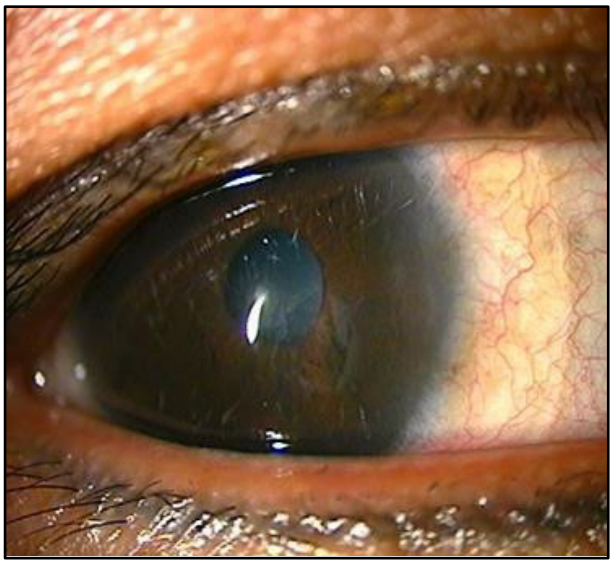
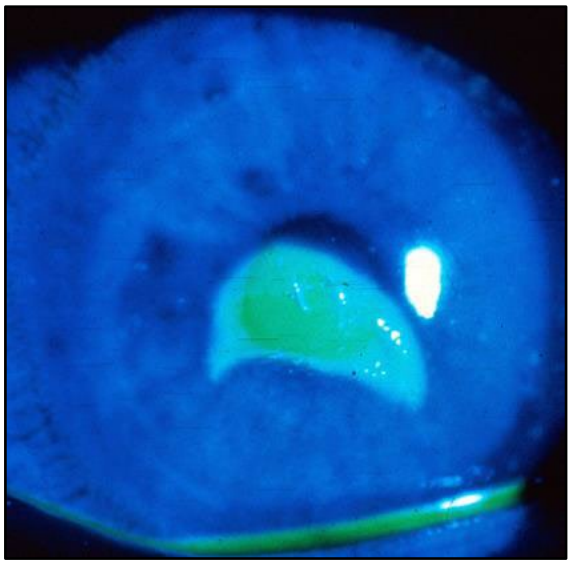


Figure 20. Epithelial defect stains with fluorescein when illuminated with cobalt blue light.
Photo credit: CAPT (Ret) Joseph Pasternak, MD.



INFECTIOUS KERATITIS / CORNEAL ULCER

These conditions are commonly associated with contact lens wear or overuse. Numerous regulations prohibit or limit wear during deployment, but contact lens use during deployment continues to be common.

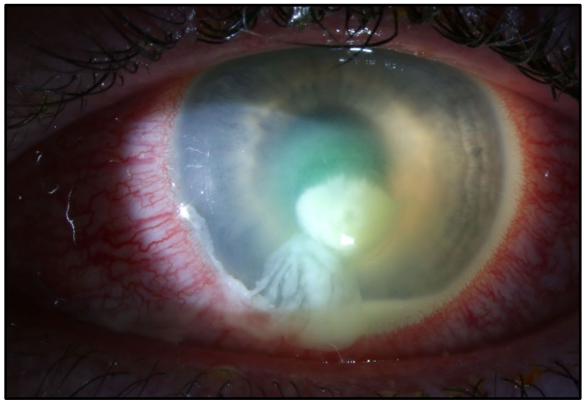
EXAM

- Epithelial defect
- Corneal infiltrate (whitish opacity in cornea)

MANAGEMENT

1. Assess and document vision if possible.
2. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology).
3. SHIELD AND SHIP.
4. Stop contact lens wear.
5. Start topical antibiotic drops if available. Instill one drop every hour while awake.
   Give fluoroquinolone (i.e. moxifloxacin, gatifloxacin, levofloxacin) OR polymyxin B/trimethoprim if available.

Figure 21. Pseudomonas infectious keratitis (corneal ulcer) from contact lens wear.
Photo credit: Lt Col Chantal Cousineau-Krieger.



CORNEAL AND CONJUNCTIVAL FOREIGN BODIES

EXAM

- Corneal or conjunctival foreign body
- If metallic, there may be a rust ring

MANAGEMENT

1. Superficial foreign bodies may be irrigated away or removed with a moistened CTA under topical anesthesia (proparacaine or tetracaine drops).
2. Start topical ophthalmic antibiotic drops or ointments if available.
3. Do NOT remove impaled or resistant foreign bodies.
4. Assess and document vision if possible.
5. Teleophthalmology consultation with eye surgeon.
6. SHIELD AND SHIP.

Figure 22. Corneal metallic foreign body.
Photo credit: © 2018 American Academy of Ophthalmology.

INTRAORBITAL FOREIGN BODY

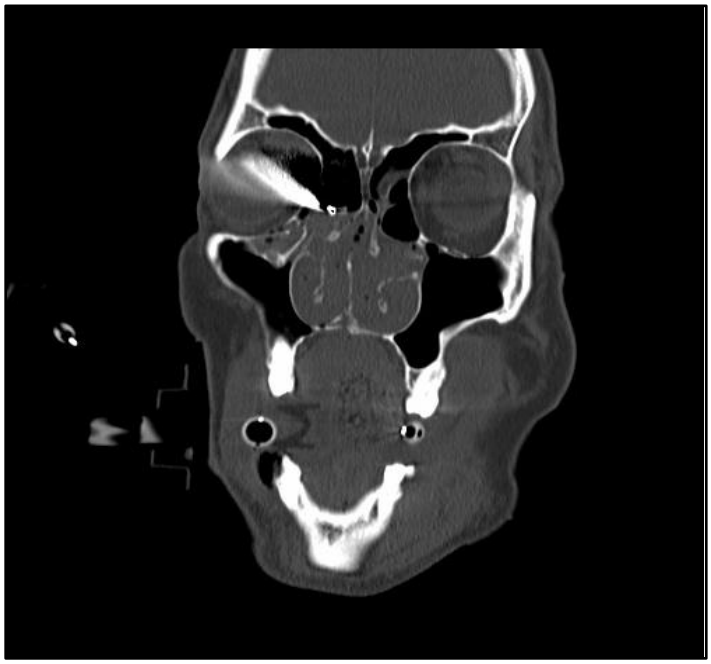
EXAM

Intraorbital foreign body visible on examination or identified on diagnostic imaging such as X-ray or CT.

MANAGEMENT

1. Do NOT remove impaled or resistant foreign bodies.
2. Assess and document vision if possible.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
4. SHIELD AND SHIP.

Figure 23. Intraorbital foreign body. Bullet in right orbit.
Photo credit: LTC Won Kim.



LASER EXPOSURES [47,48]

1. Assess and document vision.
2. Report incident to supervisor.
3. Follow the recommendations outlined in *JTS CPG Ocular Evaluation and Disposition after Suspected Laser Exposure*.[49]

LASIK FLAP DISLOCATION

1. Do NOT amputate.
2. Assess and document vision if possible.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
4. SHIELD AND SHIP.

TRAUMATIC OPTIC NEUROPATHY

HISTORY

Vision loss after eye trauma

EXAM

- Decreased visual acuity
- Afferent pupillary defect

MANAGEMENT

1. Assess and document vision and afferent pupillary defect.
2. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
3. SHIELD AND SHIP.

ANGLE-CLOSURE GLAUCOMA

HISTORY

Blurred vision or loss of vision, halos around lights, severe eye pain, severe headache, eye redness, nausea and vomiting.

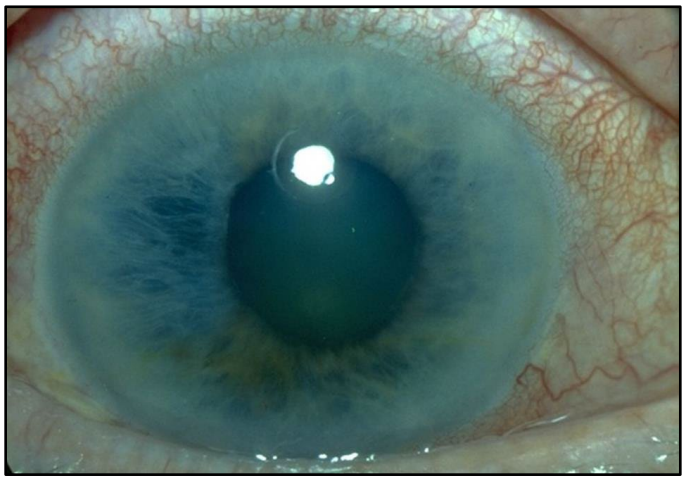
EXAM

- Palpate eyelids to see if involved eye has increased firmness compared with the opposite eye.
- Fixed, mid-dilated pupil.
- Shallow anterior chamber.
- Corneal edema (hazy cornea).
- Conjunctival injection.

MANAGEMENT

1. Assess and document vision if possible.
2. Teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
3. Give acetazolamide 500 mg PO initial dose, then 250 mg PO every 4 hours to decrease IOP if available.
4. Start intra ocular pressure (IOP)-lowering topical medications if available.
   Instill 1 drop of timolol, brimonidine, and dorzolamide 5 minutes apart. Repeat for 3 rounds.
5. SHIELD AND SHIP.

Figure 24. Acute angle closure glaucoma.
Photo credit: LTC Won Kim.



PRESEPTAL CELLULITIS

EXAM

- Eyelid redness, swelling, tenderness, and warmth.
- Usually little or no swelling or redness of conjunctiva.
- NO signs of orbital involvement including restriction of eye movement, pain with eye movement, proptosis (eye bulging forward), loss of vision, or afferent pupillary defect.

MANAGEMENT

1. Assess and document vision if possible.
2. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
3. Start oral antibiotics
   Clindamycin 300 mg PO q8hrs OR Amoxicillin-clavulanic acid 875 mg PO q12hrs if available.
4. SHIELD AND SHIP.

Figure 25. Preseptal Cellulitis.
Photo credit: Maj Brett Davies.

ORBITAL CELLULITIS

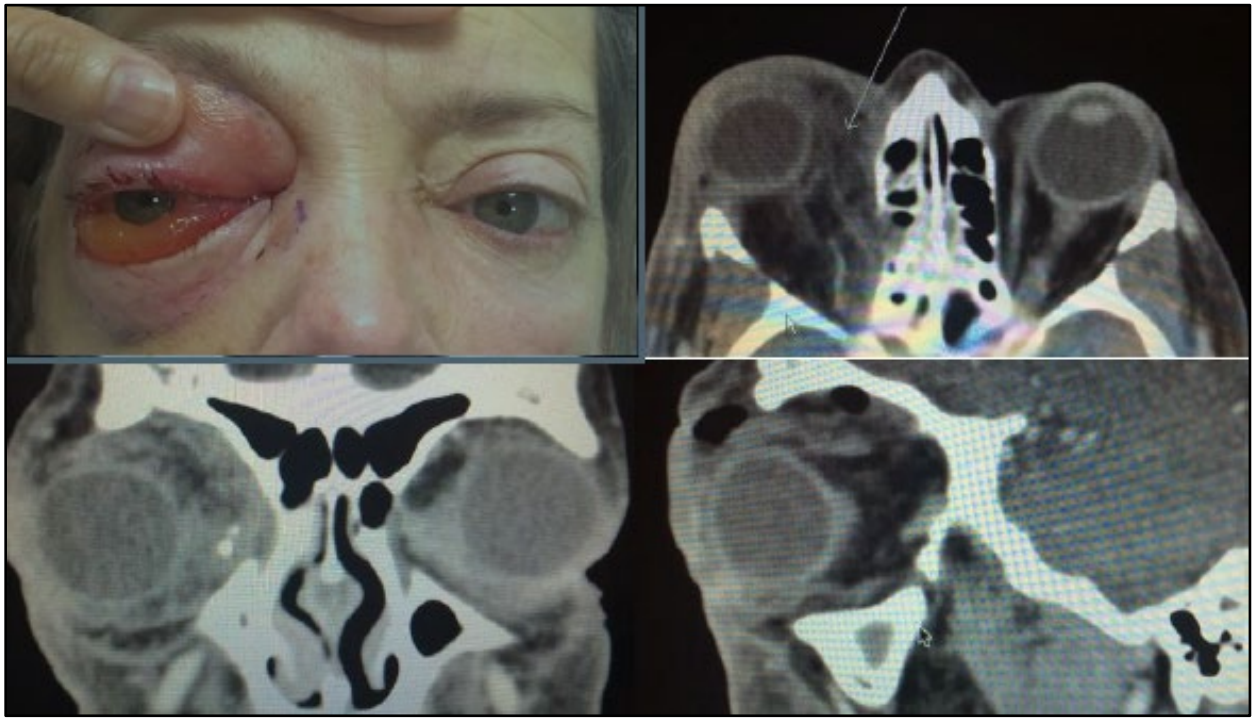
EXAM

- Eyelid redness, swelling, tenderness, and warmth.
- Swelling and redness of conjunctiva.
- Signs orbital involvement may include restriction of eye movement, pain with eye movement, or proptosis (eye bulging forward), loss of vision, or afferent pupillary defect.

MANAGEMENT

1. Assess and document vision if possible.
2. Obtain urgent CT head and orbits as soon as possible to determine if there is an abscess that needs to be surgically drained.
3. Seek teleophthalmology consultation with eye surgeon. (See Teleophthalmology.)
4. Start broad-spectrum IV antibiotics if available.[50]
    - Ampicillin-sulbactam 3 g IV q6 hours OR piperacillin-tazobactam 4.5 g IV q6 hours PLUS
    - Vancomycin 15-20 mg/kg IV per dose q8-12 hours, maximum 2 g for each dose.
5. SHIELD AND SHIP.

Figure 26. Orbital Cellulitis. Sight-threatening infection of the right orbit.
Photo credit: CDR Eva Chou.



PROTECTIVE EYEWEAR

1. Prevent eye injuries.
   a. Encourage wearing only approved eye protection – eyepro or eye-armor.[51-53]
      - MCEP
      - BPE
   b. Discourage contact lens use.
2. Look for the "APEL" label.
   a. Army's Program Executive Office – Soldier (PEO-Soldier) certifies all MCEP items to meet or exceed safety and ballistic fragmentation standards.
   b. Approved eyewear found on the APEL, available at http://www.peosoldier.army.mil/equipment/eyewear/
   c. APEL eyewear is identifiable by a neon green "APEL" logo required to be on all MCEP packaging and the "APEL" name permanently marked on the frame (located on left temple or strap).
   d. APEL eyepro comes in spectacle and goggle designs and in various sizes, with optical inserts available for some models.
   e. Service-specific policies may influence or limit the availability and variety of APEL eyepro.

f. APEL eyewear should NOT be assumed to be sufficient for occupational tasks where specific safety eyewear is required (welding, chemical protection, splash protection, or other OSHA-specified tasks).

g. Many commercial manufacturers produce "MIL-SPEC" polycarbonate eyewear, but only a few models pass the rigorous additional testing requirements.

- Many candidate models fail because of frame failure rather than lens failure.
- CAUTION: "Meets or exceeds MIL-SPEC" does not mean the model has passed APEL testing.
- Be particularly vigilant and cautious when ordering eyewear or replacement eyepro online.
- Counterfeit eyepro has surfaced in theater; beware of "bargain" eyepro. When purchasing eyepro, look for the official "APEL" marks and tags.

Figures 27, 28, 29: APEL labeling. U.S. Army Photo by PEO Soldier.

Figure 27. Neon green APEL logo required on MCEP packaging.

Figure 28. APEL eye gear.

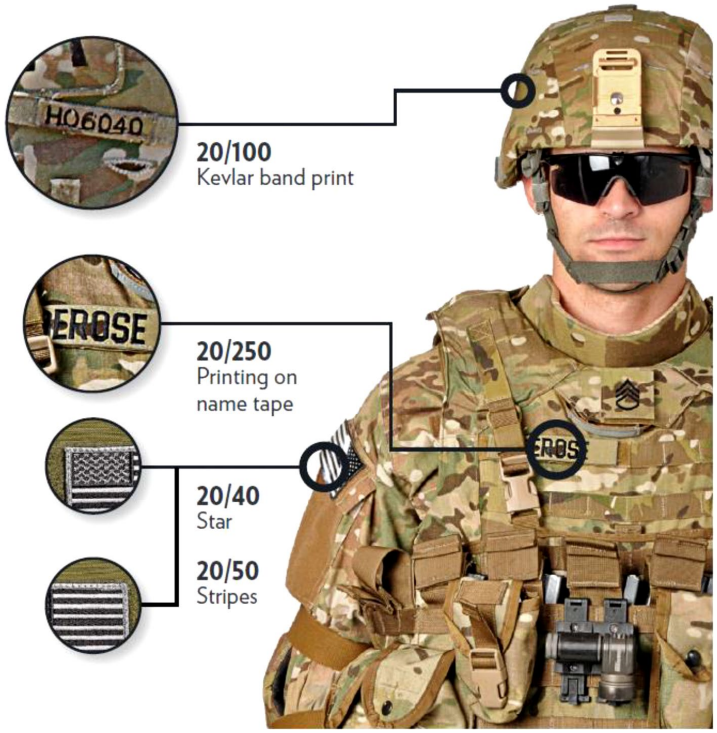
Figure 29.APEL name permanently marked on eye gear frame.

VISUAL ACUITY TESTING [8]

1. Some patients may require drop of topical anesthetic to tolerate testing.
2. Decide upon testing method.
3. Place the patient at the designated testing distance.
   a. Use Snellen eye chart if available. Start testing at 20 feet. Move patient closer if unable to see letters. Can move patient as close as 3 feet to chart.
   b. Letters and patches on the uniform can be used in the field. (See Figure 30 below.) Testing distance is 3 feet .[54]
   c. If patient is unable to see letters or patches, use the testing methods below:
      - Count fingers: Hold up one hand, extend one or more fingers and ask the patient to count the number of fingers. Record the greatest distance from the patient at which counting fingers is done accurately.
      - Hand motion: Hold up one hand and wave one hand. Record the greatest distance from the patient at which the patient can detect movement of your hand.
      - Light perception: Use a penlight or other bright light source and shine in the eye. Record the patient's response as light perception if able to detect the light. Record the patient's response as no light perception if unable to detect the light. Record the light source used for testing (e.g. penlight or flashlight).

4. Test with patient wearing glasses if available.
5. Record whether testing completed with or without glasses correction.
6. Test the right eye first by convention. Completely cover the left eye using the palm of your hand.
7. Do NOT put pressure on eye with suspected open globe injury.
8. If testing using letters, ask the patient to read the smallest line in which he or she can distinguish more than half the letters.
9. Record the acuity measurement as a notation (example 20/20) in which the numerator represents the distance at which the test is performed and the denominator represents the numeric designation for the line read.
10. Repeat the procedure for the other eye.
11. Record visual acuity for both eyes.
12. Example # 1
    - Right eye: uniform name tape 3 feet without correction.
    - Left eye: count fingers 2 feet without correction.
13. Example # 2
    - Right eye: hand motion 2 feet with glasses.
    - Left eye: stripes U.S. Flag patch 3 feet with glasses.

Figure 30. Visual Acuity Testing.
Letters and patches on a U.S. Army uniform that can be used to determine visual acuity in the field. If using this method, test from a distance of 3 feet. *Photo credit: Vision Center of Excellence.*



RAPD TESTING

1. Useful in the evaluation of unilateral or asymmetric vision loss, even in an unconscious patient.
2. "Swinging flashlight test" technique.
   a. Use bright light source such as penlight or flashlight for testing.
   b. If patient is able to follow commands, have patient fixate on a distant object.
   c. Shine light into one eye and note the pupillary response.
   d. Swing the light quickly to the opposite eye and note the pupillary response.
   e. Swing the light quickly back to the first eye while maintaining the same distance from each eye.
3. Normal response: Pupils constrict simultaneously and equally in response to light in either eye (consensual light reflex).
4. Abnormal response: When swinging light to the injured or diseased eye, both pupils constrict less or dilate (positive relative afferent pupillary defect or Marcus Gunn pupil).

HOW TO PLACE EYE SHIELD

1. Use rigid eye shield.
   - Fox shield if available. (See Figure 31a.)
   - Can use member's own eye protection if intact or minor damage. (See Figure 31b.)
   - Other rigid materials that do not place pressure on the eye can be used as an eye shield - like a cup. (See Figure 31c.)
2. Position shield so rim of the orbit supports it when taped.
3. Secure shield with tape. Recommend 3 strips or enough to secure.
4. Shield ONLY injured eye. Shielding both eyes increases patient anxiety.
5. DO NOT patch. It puts pressure on eye. (**DO shield but DO NOT patch**).
6. Do NOT wrap. It puts pressure on eye.
7. Do NOT place anything under an eye shield including gauze.

Figure 31. Eye shields.

Figure 31a. Fox shield.

Figure 31b. Can use member's own eye protection if intact or minor damage.

Figure 31c. Other rigid materials as eye shield. Materials do not place pressure on the eye can be used as an eye shield - like a cup.

CONTINUOUS IRRIGATION USING MORGAN LENS

SUPPLIES NEEDED USING MORGAN LENS

1. Topical anesthetic (0.5% Proparacaine or 0.5% Tetracaine)
2. Morgan Lens
3. IV tubing set and IV pole
4. Irrigating solution – best solution choice is normal saline or lactated Ringer's
5. Fluid collection equipment (basins, bowels, or MorTan Medi-Ducts)
6. pH paper or urine dipstick strips

STEPS USING MORGAN LENS[55]

Figures 32A. Continuous irrigation using Morgan Lens[55]
Source: Images reprinted from Morgan Lens Instructional Chart. Courtesy of Morgan Lens, MorTan Inc.

Step 1. Figure 32A-1. Instill topical anesthetic to traumatized eye(s).

Step 2. Figure 32A-2. Connect 1/2 Morgan Lens to delivery IV tubing set.

Step 3. Figure 32A-3. Start minimal flow of irrigation solution.

Step 4. Figure 32A-4. Insert Morgan Lens. Have patient look down. Retract upper eyelid. Insert lens under retracted upper eyelid. Have patient look up. Retract lower eyelid. Insert lens under lower eyelid. Instruct patient to keep eye(s) closed.

Step 5. Figure 32A-5. Adjust fluid flow, tape lines to forehead of patient, place fluid collection equipment.

Step 6. Figure 32A-6. Remove Morgan Lens. After neutral pH point achieved (pH 7.0 to 7.5), stop fluid flow to instill topical anesthetic, then restart fluid flow. Have patient look up and retract.

CONTINUOUS IRRIGATION USING NASAL CANNULA

SUPPLIES NEEDED

1. Topical anesthetic (0.5% Proparacaine or 0.5% Tetracaine)
2. Irrigating solution – best solution choice is normal saline or lactated Ringer's
3. IV pole
4. Pressure infuser
5. IV tubing
6. Nasal cannula
7. Connection between IV tubing and nasal cannula tubing. (See Figure 32B-2).
   - Tubing connector
   - Stopcock connector
   - Syringe tip cap (cut off top with scissors)
8. Irrigating solution – best solution choice is normal saline or lactated Ringer's.
9. Fluid collection equipment (basins, bowels, or MorTan Medi-Ducts)
10. pH paper or urine dipstick strips

STEPS

1. Instill topical anesthetic to traumatized eye(s)
2. Hang IV fluid on IV pole inside pressure infuser.
3. Spike and prime IV tubing.
4. Connect IV tubing to nasal cannula tubing.
5. Position nasal cannula on forehead so prongs provide continuous irrigation into both eyes.

6. Run continuous irrigation wide open until neutral pH point achieved (pH 7.0 to 7.5)

Figure 32a-c. Continuous irrigation for chemical injury using nasal cannula.

Figure 32a. Normal saline or lactated ringers inside pressure infuser.

Figure 32b. Connectors can be used to connect IV tubing and nasal cannula tubing (left to right): tubing connector, stopcock connector, syringe tip cap (cut off top with scissors).

Figure 32c. Position nasal cannula on forehead so prongs provide continuous irrigation into both eyes.

LATERAL CANTHOTOMY AND INFERIOR CANTHOLYSIS

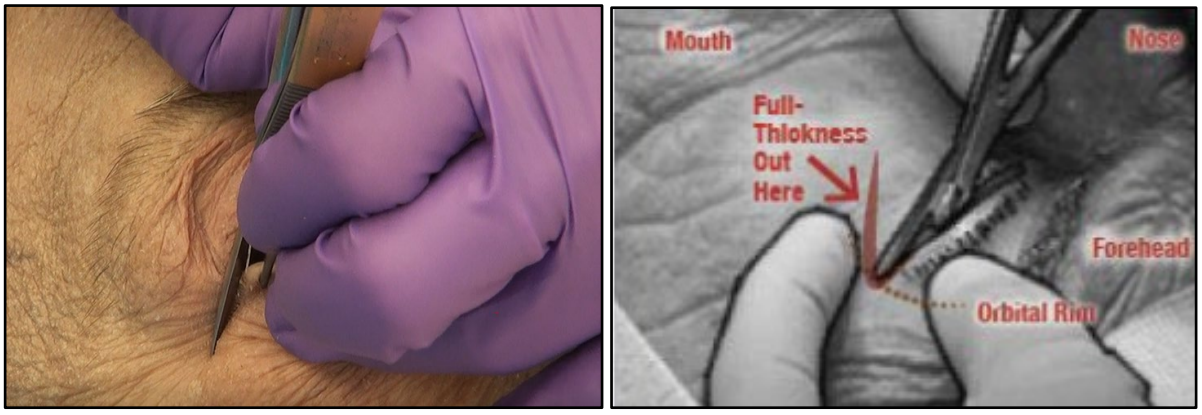
1. If possible, give subdermal injection of lidocaine 2% with epinephrine to the lateral canthus. It can be difficult to inject tissue that is already swollen.
2. Optional only if good local anesthesia. Apply a hemostat or needle driver horizontally at the lateral canthus for 1 minute to reduce bleeding.
3. Perform lateral canthotomy.
   Use blunt scissors to incise the lateral canthus, FULL THICKNESS, for 1-2 cm to the lateral bony orbital rim (canthotomy).
4. Perform inferior cantholysis:
   a. With toothed forceps, grasp the lower eyelid firmly at the edge of the incised canthus (at the orbital rim) and apply traction away from the eye.
   b. Keeping one scissor blade behind the lid (in the conjunctival fornix) and one blade over the skin, angle the scissors toward the corner of the mouth or nasal ala. Make a FULL THICKNESS cut across the lower lid for length of 1-2cm. This should fully disinsert the lid. You may be able to palpate or “strum” the inferior part (inferior crus) of the lateral canthal tendon as a “guitar string” before cutting.
   c. If successful, the eyelid should swing freely and come completely away from the globe. If the eyelid remains in its normal position, use scissors tips to feel for residual tethering bands, and continue cutting until the lid swings freely.
   d. There may not be a “gush of blood” even with successful release.

5. Recheck vision and intraocular pressure. If the intraocular pressure remains elevated with poor vision and a tense orbit, then perform superior cantholysis, separating the upper lid from the orbital margin. Also consider giving 500MG IV acetazolamide.

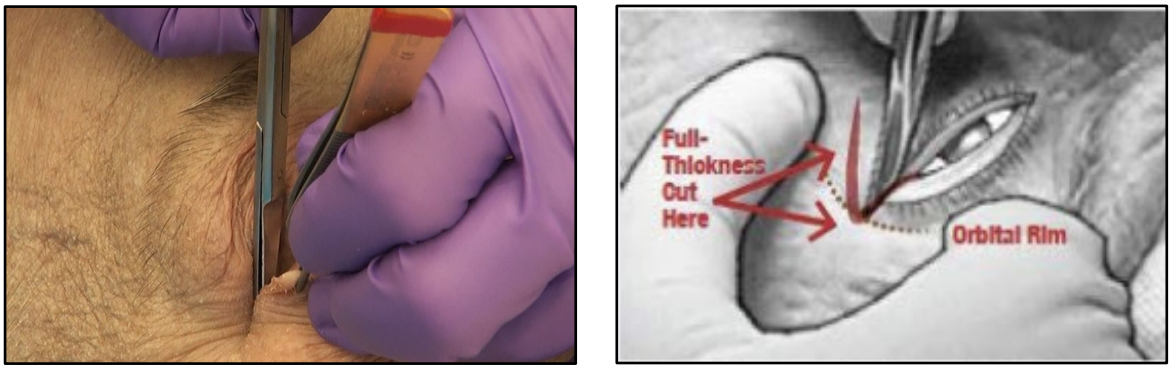
Figure 33. Technique for lateral canthotomy and inferior cantholysis.
Photo credit: CDR Eva Chou.

Figures A and B. *Perform lateral canthotomy. Use blunt scissors to incise the lateral canthus for 1-2 cm full thickness to the bony orbital rim.*

Figures A

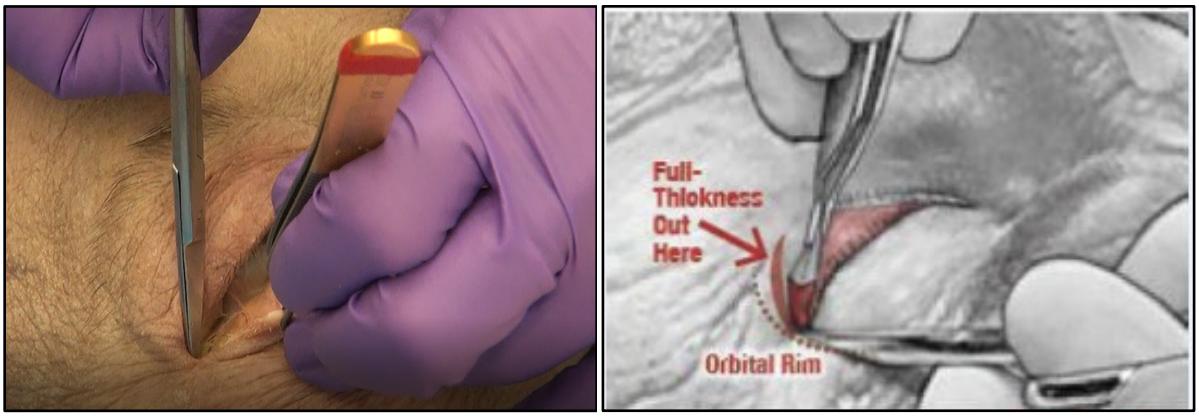


Figures B

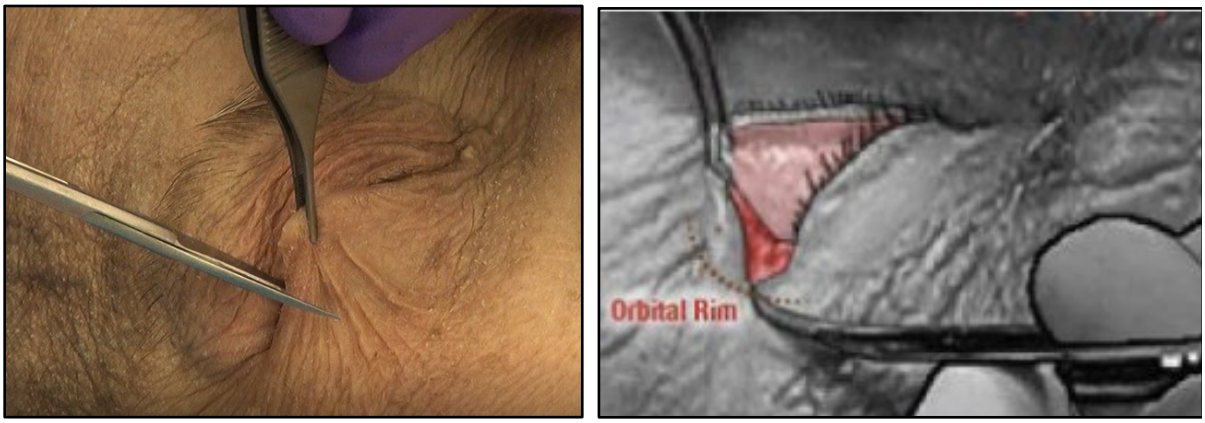


Figures C and D. *Perform inferior cantholysis. With toothed forceps, grasp the lower eyelid at the edge of the incised canthus and apply traction away from the eye. With one scissors blade behind the lid and one over the skin, angle the scissors toward the corner of the mouth or nasal ala. Make a FULL THICKNESS cut across the lid for 1-2cm. You may be able to palpate or "strum" the inferior part (inferior crus) of the lateral canthal tendon before cutting. If successful, the eyelid should swing freely and come completely away from the globe. If the eyelid remains in its normal position, strum for residual tethering bands and continue cutting until the lid is fully released. There may not be a gush of blood, even with successful release.*

Figures C



Figures D



EYE ANATOMY

Figure 34. Eye Anatomy.
Photo credit: 2019 American Academy of Ophthalmology.

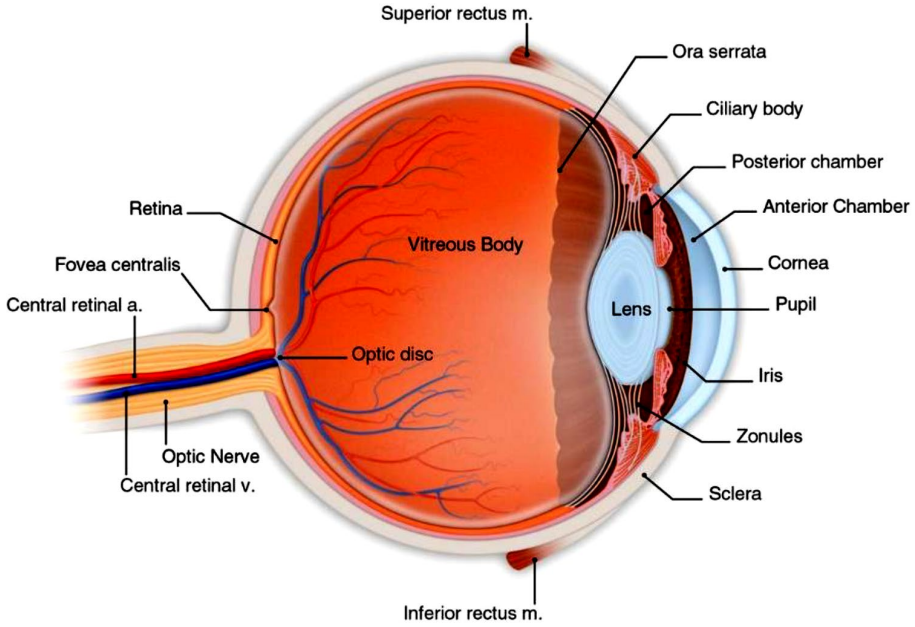
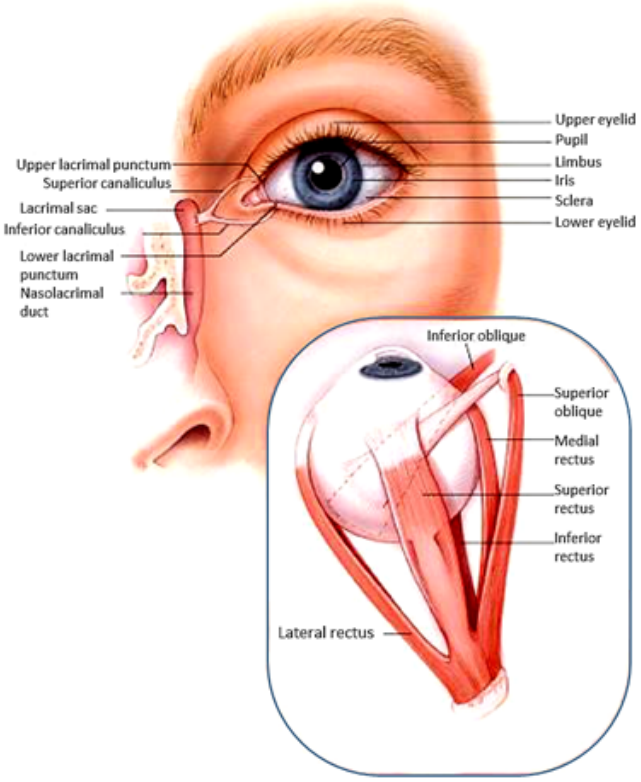


Figure 35. External landmarks and extraocular muscles of the eye.
Photo credit: 2019 American Academy of Ophthalmology.



AEROMEDICAL EVACUATION CONSIDERATIONS

Due to the requirement to move the coalition patient with vision-threatening injuries to a Role 3 with an ophthalmologist in theater or Role 4 outside the area of responsibility (AOR), early and safe transport of these patients should involve consideration of several factors.

1. Initiate teleophthalmology consultation with an ophthalmologist as soon as possible.

2. Management of concomitant injuries is crucial during flight.

3. After open globe injury, rotary wing aeromedical evacuation may be accomplished in theater without prior clearance by an ophthalmologist.

4. Teleophthalmology consultation with an ophthalmologist is recommended before fixed wing transport of an open globe injury. Typically the patient is cleared for immediate transport. If available, CT imaging of the orbit with thin slices can identify if there is trapped intraocular air, which could cause an acute rise in intraocular pressure or extrusion of intraocular contents in a depressurized cabin. In this situation, the aircraft commander should be notified that the internal cabin pressure should be maintained between sea level and 2500 feet to keep gas expansion at or below 10%. The aircraft commander can determine a safe aircraft altitude for that mission based on that information. For example, if the transport aircraft is a C-17, cabin altitude can be up to 2500 feet and allow the aircraft to fly safely at 24,000 feet.

5. Vibration and turbulence can also be increased during flight. Adequate immobilization of foreign bodies to prevent further injury. Pain related to traumatic injuries is exacerbated by vibration and adequate pain medication is required.

6. Decreased visual input will increase the risk of motion sickness. Vomiting can increase the risk of further injury. Anti-emetics can help to mitigate this risk.

7. The need to Valsalva or perform similar maneuvers to equalize middle ear pressure can further injure the eye and surrounding structures, particularly the inferior orbit which overlies the maxillary sinuses. Adequate rapid acting decongestants (i.e. Afrin) can be used.

8. Air handling systems on board the aircraft result in a very low relative humidity. Generous use of medications to lubricate the eye may be necessary.

9. Patients with eye injuries cannot generally safely navigate inside aircraft due to poor lighting and cramped space and decrease in visual cues to balance. Consider placing the patient on a litter for safety and a non-medical attendant to help patient move if needed.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients with diagnosis of eye injury.
- All patients with a diagnosis of retrobulbar hematoma or orbital compartment syndrome.

INTENT (EXPECTED OUTCOMES)

1. All patients in populations of interest have visual acuity tested and documented in both eyes at all roles of care (including point of injury). If the patient is unresponsive or intubated and sedated this is documented and the pupils are checked for a relative afferent pupillary defect.
2. All patients in populations of interest have a rigid eye shield placed correctly and documented at all roles of care (including point of injury) that do not have an ophthalmologist.
3. All patients with open globe injuries receive appropriate antibiotics at the first role of care.
4. All patients with a diagnosis of retrobulbar hematoma or orbital compartment syndrome receive an immediate full thickness lateral canthotomy and inferior cantholysis.
5. All patients in populations of interest receive a teleophthalmology consultation.
6. All patients in population of interest with vision-threatening injuries are evacuated so that they are able to receive treatment by an ophthalmologist within 24 hours. If evacuation is not possible, the reason for the delay is documented.

PERFORMANCE / ADHERENCE MEASURES

1. Number and percentage of patients in the populations of interest that have visual acuity tested and documented in both eyes.
2. Number and percentage of patients in the populations of interest who have rigid eye shield placed correctly and documented at all roles of care (including point of injury) that do not have an ophthalmologist.
3. Number and percentage of patients with open globe injury who receive appropriate antibiotic at the first role of care.
4. Number and percentage of patients with a diagnosis of retrobulbar hematoma or orbital compartment syndrome who receive an immediate full thickness lateral canthotomy and inferior cantholysis.
5. Number and percentage of patients in the populations of interest who receive a teleophthalmology consultation.
6. Number and percentage of vision-threatening injuries that are evacuated so that they are able to receive treatment by an ophthalmologist within 24 hours. If evacuation not possible, the reason for the delay is documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Frostbite and Immersion Foot Care (CPG ID: 59)

This CPG provides an overview of cold injuries and presents a standardized approach to providers in the evaluation and treatment of patients with cold injuries including the role of intravascular therapy

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BACKGROUND

Historically, cold Injury, hypothermia and frost bite have been a severe problems for military units on the battlefield.[1] While not common in modern conflicts, the potential exists for large numbers of these casualties in war and during training.[2,3] Cold injury requires two things: a low absolute temperature and an exposure duration. In general, the human body contains the mechanisms to preserve core body temperature and extremities even if limb perfusion is temporarily impeded in order to preserve core body temperature. When these mechanisms are overwhelmed, the result is permanent tissue damage. The ultimate mechanism of injury involves a combination of direct cold injury to the cells, direct intracellular and intercellular ice formation, ischemia from thrombosis of the vasculature, and reperfusion injury.[4] The patients that are afflicted with cold injury generally fall into one of two categories: those involved in industrial accidents and those unable to escape their environment. Patients in the military predominantly will fall into the category of inability to escape the environment. Unlike other types of injuries, all forms of cold injury are potentially preventable with knowledge, equipment, and foresight. Acclimation to the environment provides some protection while those of African descent have increased susceptibility to cold injuries.[5]

Increased rates of frostbite occur at extreme high altitude secondary to ambient temperature decreases and microcirculatory changes that occur at altitudes greater than 17,00ft.[6,7]

EVALUATION

TRAUMA EVALUATION

All patients with identified cold injury should be considered trauma patients first to identify other life threatening injuries. If possible, attempt to establish the circumstances which led to prolonged environmental cold exposure. In addition, patients are likely hypothermic and should be warmed expediently before focusing on cold injuries of the extremities. In the field, cold extremities may be warmed as a consequence of treating a hypothermic patient. It is imperative to prevent refreezing of the impacted extremity as it results in more tissue damage.

COLD INJURIES

Cold injury is not a single diagnosis but rather a spectrum with all categories possibly present on a single extremity, the most distal portion usually being the most severely affected. Normothermia must be established prior to making the diagnosis of cold injury. Many people experience numbness of extremities with prolonged cold exposure with return to normal function without any permanent damage; this in isolation, will not result in cold injury. Cold injury has occurred when upon re-warming there is pain and swelling or gross signs of ischemia or skin injury. There are classically four degrees, with depth of injury distinguishing the different degrees:

First Degree: Superficial skin injury; pain on re-warming, numbness, hyperemia, occasional blue mottling, swelling and superficial desquamation (desquamation starts at about 5 days)

Second Degree: Partial thickness injury to skin; in addition to first degree findings, vesiculation of the skin surrounded by erythema and edema (appears around day 2)

Third Degree: Entire thickness of skin extending into subcutaneous tissue; bluish to black and non-deformable skin, hemorrhagic blisters, vesicles may not be present, eventual ulcerations can be expected; area will likely be surrounded by 1st or 2nd degree injury

Fourth Degree: Similar to third degree, but full thickness damage including bone. Area may be cold to touch and may feel stiff or woody.

Another way to classify is superficial (First and Second Degree) and full thickness (Third and Fourth Degree) similarly to burns. The ultimate grade will not be truly known until treatment has been attempted and a period of time has passed.

There are very mild cold injuries labeled as Chilblains and Frostnip that do exist, but for the sake of caution in the field, the recommendation is to treat all acute presentations as first degree (superficial) frostbite as there is no morbidity in correcting hypothermia and rapid rewarming of suspected areas. Chilblains is a chronic condition, like a dermatitis, and if continues after initial treatment cold avoidance and supportive care can be provided.

IMMERSION FOOT

Commonly known as trench foot, it is a syndrome related to prolonged exposure to moisture. Classically it has been associated with cold water, but can happen in all climates. The syndrome generally happens slower in warm water, taking approximately 48 hrs, than cold water (earliest estimate 12 hours).

The clinical presentation is water logging of the feet, most pronounced in the soles. With continuous exposure, the foot becomes hyperemic, mottled, painful and edematous, gradually progressing into blistering, hypoperfusion, ulceration and gangrene.[8,9]

TREATMENT

COLD INJURY/FROSTBITE

Rapid Re-warming and Re-establishment of Perfusion

The mainstay of treatment of the cold injury is re-warming. **Rapid active re-warming is done in 104-108°F (40-42°C) water for 15- 30 minutes** as long as care can occur in an environment where there is no risk of refreezing. The temperature is important, as there is reduced effect with cooler temperatures and higher temperatures will cause burns. Passive re-warming or dry heating is not considered acceptable, but may be the only option depending on the operational environment and involves using body heat and blankets; always attempt to move the casualty safely to a warmer environment. Do not use blow driers, space heaters, or the like as these will cause burns. The goal is complete thawing and maximum perfusion as evidenced by hyperemia, swelling, and pain.[10] Rubbing the affected areas is to be avoided as this will further traumatize the skin**. The re-warming process can be expected to be very painful and narcotic and non-steroidal medications, including Ibuprofen/Aspirin and/or Ketamine should be utilized liberally.** It is tempting to re-warm slowly because this is better tolerated but tissue survival is improved with rapid re-warming. Pain usually subsides in approximately 3 days but prolonged aches, shooting pains, and throbbing can be expected for weeks.[1] Early surgical consultation should be made. Rapid re-warming can be conducted at point of initial care, but early evacuation to definitive care should be considered at the earliest available time. It is also very important that when rapid re-warming is done, it is to be completed, as refreezing after partial thawing will result in more severe injury.

During the course of treatment, patients should be prohibited from using any tobacco and nicotine-containing products as well as any medications inducing vasoconstriction. The limb should be elevated to reduce swelling. After re-warming, electrolyte abnormalities and rhabdomyolysis can occur. Electrolytes should be monitored every 6 hours initially, until normalized. Scheduled ibuprofen (400 mg PO every 6 hours) should be considered, with narcotics utilized for refractory pain. Sympathectomy and vasodilators have been attempted in studies, but there is insufficient evidence that these modalities improve outcomes and should not be routinely attempted. If available, hyperbaric oxygen can be considered and started between day 5 and 10.[4] Evidence for the use of systemic prophylactic antibiotics is lacking and is not recommended. Regular application of topical aloe vera

may help limit tissue loss.[4] After resolution of edema, whirlpool therapy combined with exercise can help maximize functional recovery of the extremity.

Photo documentation at point of injury when feasible can assist in continuum of care.

Thrombolytic Therapy

Care must be made to ensure patients are candidates for Tissue Plasminogen Activator (tPA) prior to therapy (see below). Patients should be within 24 hours of the start of injury. Patients should have evidence of severe frostbite as well as circulatory compromise as demonstrated by decreased or absent pulses, lengthened capillary refill, and/or ischemic discoloration of distal digits.[11]

Candidates for tPA:

- Within 24 hours of start of injury.
- Evidence of injury with vascular compromise.

Relative contraindications to tPA for frostbite injury include:

- Concurrent trauma.
- Recent surgery or hemorrhage.
- Bleeding diathesis.
- Cold contact injury without frostbite injury.
- Greater than 24 hours of ischemia.
- Evidence of freeze-thaw-freeze injury.

Patients that are being considered for therapy should be taken for diagnostic arteriogram of the affected extremity. If perfusion is compromised, papaverine, a vasodilator, may be introduced intraarterially at a rate of 30 mg/hr to decrease local vasospasm. Intraarterial tPA should be administered through the arterial catheter as follows: 2-4 mg bolus followed by a continuous infusion of 0.5-1.0 mg/h into the extremity. If multiple extremities are involved, arterial catheters are positioned in each extremity. The maximum dose of tPA would then be divided amongst the number of extremities. For example, if two extremities are involved, the maximum rate for each extremity is 0.5 mg/h. In addition, intraarterial heparin should be administered through the arterial sheath at a rate of 500 units/h to prevent new clot formation and extension of existing thrombi. Serial labs including PTT, fibrinogen, Hgb/Hct, and platelets are repeated every 6 hours. There is no PTT goal as the dose is small for a normal-sized adult. Angiograms are to be repeated every 8 to 12 hours to evaluate response to therapy. Termination of therapy is recommended to end with complete perfusion or at 48 hrs, unless complications from tPA occur or fibrinogen levels fall below 150. Patients should be closely monitored for hemorrhagic complication, neurologic, and cardiovascular complications from the tPA. If a patient develops serious bleeding complications, the tPA and heparin should be discontinued. If revascularization has occurred, and final cessation of tPA is made, heparin should be continued for at least 72 hours.[11,12]

A systemic, intravenous approach to tPA administration is available, but only with the ability to perform technetium scanning to confirm vascular compromise and response to therapy. The systemic approach is administration of a tPA bolus of 0.15 mg/kg intravenously followed by a 0.15 mg/kg/hr infusion over the next 6 hours to a maximum dose of 100 mg. After completion of tPA, heparin is started with a goal of two times normal control and is continued until conversion to Coumadin. Anticoagulation with Coumadin should be continued for 4 weeks.[13]

tPA should be avoided in a setting that lacks the ability to monitor and treat bleeding complications.

DEBRIDEMENT

Major surgical debridement, should not be performed in the operational environment for US Military or casualties that can be evacuated. Early excision is not part of the therapy for frostbite. Excision should be delayed until margins of injury are fully demarcated; this may take months. For minor injuries, local wound care can be performed with the addition of topical antibiotic and aloe vera gel or a sterile topical emollient every 6 hours. Wound care should be performed BID and sterile non-adherent dressing should be applied. Vesicles from second degree become dry, black, and hard in approximately 2 weeks and will generally peel away at 3-4 weeks.

Third degree frostbite forms an eschar and can be debrided in approximately 2-8 weeks depending on severity of the injury. There will be an ulcer and this will take further time to heal. The surrounding skin is easily traumatized from second degree frostbite.

With fourth degree frostbite, the mummification of the extremity or digit will become readily apparent in approximately 2 weeks. Most will continue the mummification process without sequelae and this should be a minimally painful process, but throbbing, shooting pains, and potentially severe aching can be expected for up to a month. Some moisture and purulence can be expected without significant concern unless signs of local or systemic sepsis present. The level of debridement/amputation can be delayed until mummification is complete.

For cases of full thickness injury (third and fourth degree) with infection, debridement and possible amputation are to be conducted expediently.

In general, surgical debridement should be done at a definitive care site outside of theater.

SUPPORTIVE CARE

Cold injury may have permanent symptoms after the injury. It is common to have patients with minimal injuries complain of persistent coldness, pain, and hyperhidrosis of the affected extremity. In addition, second degree frostbite will likely have intact, but easily damaged, skin. In many cases, patients are more susceptible to future cold injury which frequently is more severe than the initial insult.

Basic treatment for persistent side effects includes nonsteroidal analgesics and antiperspirants. These should be available at forward operating locations until further definitive dermatologic and surgical care can be provided.[14]

Mild injury can be managed at site of injury but any full thickness injury should be evacuated.

Tetanus booster should be provided based on immunization history.

IMMERSION FOOT

Similar to frostbite, re-warming of the extremity is required. This is done by **air drying at room temperature**. Pain control may be required along with debridement. Prophylactic antibiotics have not been shown to result in improved outcomes, but if concerned that infection is present, treatment should target streptococcal, staphylococcal, and *P aeruginosa* based on local antibiogram while awaiting any available cultures.[9] Similar to other cold injuries, persistent life altering symptoms can persist.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients diagnosed with cold injury (frostbite) or immersion foot.

INTENT (EXPECTED OUTCOMES)

1. Patients with diagnosis of frostbite have rewarming of affected extremities with 104-108°F (40-42°C) water.
2. Patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury receive TPA, unless documented contraindication.
3. Patients with immersion foot have dry heat administered.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have documentation of treatment with water heated to 104-108°F (40-42°C).
2. Number and percentage of patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury who receive TPA.
3. Number and percentage of patients with severe cold injury (frostbite with tissue necrosis) AND who undergo rewarming within 24 hours of the start of cold injury who receive TPA or have a contraindication documented.
4. Number and percentage of patients with immersion foot who have documentation of dry heat administered.

DATA SOURCE

- Patient record
- Department of Defense Trauma Registry (DODTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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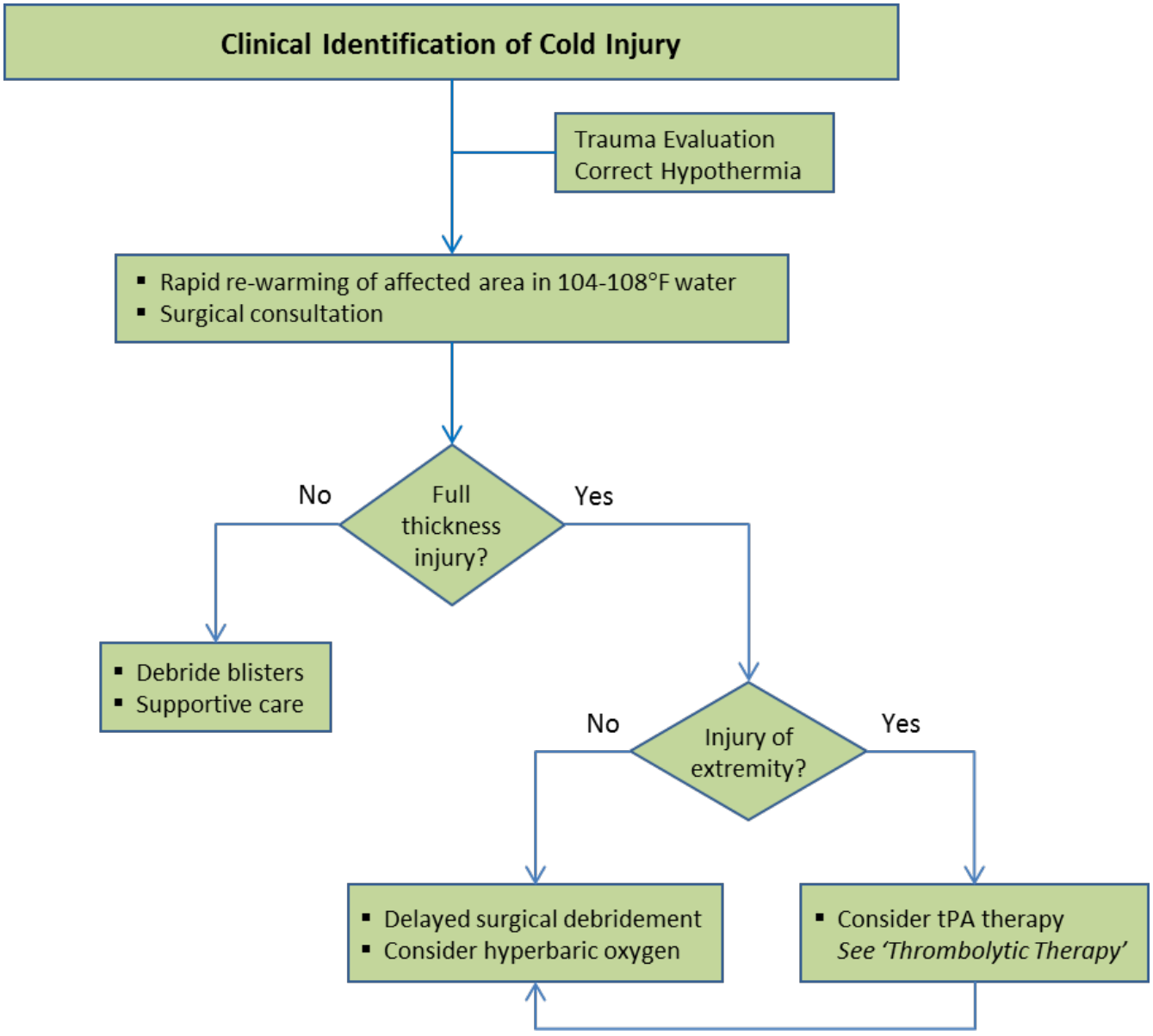
APPENDIX A: CLINICAL IDENTIFICATION OF COLD INJURY



APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

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With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Frozen and Deglycerolized Red Blood Cells

Provide guidance for the use of frozen and thawed/deglycerolized red blood cells in the combat theater.

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Sep 2023 update: clarification of deglycerolization process of one blood unit on an Automated Cell Processor-215

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BACKGROUND

Deglycerolized Red Blood Cells (DRBCs) are derived from 450-500 ml of whole blood collected in Citrate/Phosphate/Dextrose (CPD) or Citrate/Phosphate/Dextrose/Adenine (CPDA-1) collection bags. DRBCs can also be made from additive solution Red Blood Cell (RBC) units such as CPD/AS-1, CPD/AS-5 or CP2D/AS-3 if these are first centrifuged to concentrate the RBCs to hematocrit of about 75%. The RBCs are stored for up to 6 days at 1 – 6 °C before being frozen in a cryoprotectant (40% w/v glycerol) and stored in the frozen state at minus 65 °C or colder for up to 10 years. Once it is determined that they will be needed for transfusion, the frozen RBCs are thawed. They are then deglycerolized by sequential washing with hypertonic (12%) saline followed by normal (0.9%) saline mixed with 0.2% glucose. Following deglycerolization, they are re-suspended in AS-3 additive solution and stored at 1 – 6 °C, until ready for transfusion. DRBCs suspended in AS-3 are Food and Drug Administration (FDA)-approved for transfusion for up to 14 days when processed on the Haemonetics Automated Cell Processor ACP215, an FDA 510(k)-cleared, closed processing system device. DRBCs are licensed under the respective Service Blood Program licenses.

The first operational frozen blood bank was established in 1956 at Chelsea Naval Hospital (Boston), in part to determine the practicality of frozen blood usage aboard Navy ships. In 1966, under Department of Defense (DoD) direction, the Navy Bureau of Medicine and Surgery established the first frozen blood bank in a combat zone at Navy Station Hospital, DaNang, Republic of South Vietnam. Over a seven-month period, 465 DRBC units were transfused to severely injured casualties. In the 1980s, the DoD froze 68,000 RBC units. Those units were pre-positioned throughout several geographic Combatant Commands in direct support of current and future military medical contingency operations.

FDA-approved DRBCs are typically used at Role 2 and higher Medical Treatment Facilities (MTFs) but could be used in the pre-hospital setting after thawing and deglycerolization if appropriately transported. DRBC storage and processing are organic to certain naval vessels and Service depots in the Pacific Command (PACOM) Area of Responsibility. Army MTFs and Medical Detachment Blood Support units do not have the organic mission or capability to process and store frozen units of blood. Use of this capability is based on operational necessity outside of PACOM.

CLINICAL INDICATIONS FOR USE

Each unit of DRBCs:

- Should be considered equivalent to a fresh unit of RBCs since they are frozen within 6 days of collection and have a 14-day shelf-life upon deglycerolization.
- Contains more than 80% of the RBCs present in the original unit of blood.
- Provides the same physiologic benefits as liquid RBCs.
- Carries the same expectation for post-transfusion survival as liquid-stored RBCs.
- Contains significantly lower concentrations of proteins associated with non-hemolytic transfusion reactions.
- **The primary indication for use of frozen and deglycerolized RBCs is as a supplement to liquid RBCs during surge periods of increased transfusion requirements in order to decrease casualty hemorrhagic morbidity and mortality.**

  DRBCs may be used in lieu of liquid-stored RBCs for all RBC transfusion requirements including massive transfusions. The Joint Trauma System (JTS) Performance Improvement Branch analyzed data from the DoD Trauma Registry (DoDTR) and Massive Transfusion database and found no statistically significant

difference in outcomes or transfusion-related complications between patients who received at least 1 unit of DRBCs as part of their massive transfusion and those who received none (See Appendix A). A single center prospective randomized trial comparing DRBCs to liquid-stored RBCs in stable trauma patient's revealed decreased inflammatory marker and D-dimer levels and increased tissue oxygenation measured by near infrared spectroscopy in patients transfused DRBCs. There were no differences in clinical outcomes.

- Transfusion monitoring:
  - **Clinical:** Treat as a routine liquid-stored RBC transfusion before, during, and after transfusion, and for a suspected or actual adverse event.
  - **Laboratory:** Consider obtaining pre- and post-transfusion Hgb/Hct and Base Excess/Deficit or lactate levels.

DOCUMENTATION

Clinical documentation for a frozen and deglycerolized transfusion is the same as for a liquid transfusion. In addition:

1. The **physician** may order use of DRBCs (for example, when washed RBCs would be preferred to reduce risk of transfusion reaction to plasma proteins in some patients), but in practice, the MTF will use DRBCs and liquid-stored RBCs interchangeably based on inventories and logistical considerations.
2. The **laboratory** will establish and maintain a process to document DRBC transfusions in a manner that will facilitate future evaluation of recipients, including but not limited to:
   - Blood component identifiers.
   - Date of blood component receipt in frozen state.
   - Date of thaw/deglycerolization/additive process and resulting expiration date.
   - Casualty identifiers (including nationality and ABO/Rh categorization).
   - Date of transfusion.
   - Transfusion indication.
   - Transfusion reaction, nature, and outcome.

OPERATIONAL CONSIDERATIONS

Thawing and deglycerolization are time-consuming processes. Thawing a frozen RBC unit takes about 35 minutes in a plasma thawer and about 45 minutes in a 42°C water bath. The process of deglycerolization of one blood unit on an Automated Cell Processor (ACP)-215 takes approximately one hour, not including time for initial unit thawing and labeling/release of deglycerolized product. When using multiple ACP215s, maximal throughput from initial thawing to unit release/availability can average up to 1 U every 2-3 hours per device. However, problems with device performance, supply limitations, and technician training can lead to slower availability times. In periods of predictable operational requirements, it may be advisable to pre-thaw and deglycerolize several units so as not to incur the delay of preparation at the time they are needed.

PERFORMANCE IMPROVEMENT (PI) MONITORING

INTENT (EXPECTED OUTCOMES)

All patients who receive DRBC transfusions have accurate documentation in the medical record of the quantity of transfused blood and any transfusion-related adverse events.

PERFORMANCE/ADHERENCE MEASURES

In patients who were transfused DRBCs, there was accurate documentation in the medical record as to the quantity of blood transfused and any transfusion-related adverse events.

DATA SOURCE

- Patient Record
- DoDTR
- CENTCOM blood bank logs
- Theater Medical Data Store

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed biannually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the combined responsibility of the trauma team leader and blood bank officer to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: MASSIVE TRANSFUSION WITH DRBC COMPARED TO STANDARD MASSIVE TRANSFUSION

	p value	
Overall Mortality	0.241	63 cases/63 controls matched for age, ISS, total RBC within 24 hours, patient category, gender
Complications	**p value**	
Transfusion Reaction	N/A	No cases in sample
Coagulopathy	0.271	63 cases/63 controls matched for age, ISS, total RBC within 24 hours, patient category, gender, initial Base deficit, initial temperature, initial INR
Renal Failure	0.57	60 cases/60 controls matched for age, ISS, total RBC within 24 hours, patient category, gender, extremity injury
DVT	0.753	23 cases/23 controls matched for age, ISS, total RBC within 24 hours, patient category, gender, extremity injury
Respiratory Failure	N/A	No cases in sample

Sixty-three patients in Afghanistan were identified between Jan 10 - Sep 11 as having a massive transfusion which included deglycerolized blood (DRBC). A control population of 525 patients with non-DRBC massive transfusion from the same time period and theater was found in the JTTR to provide comparison of overall mortality.

CONCLUSION: With the data available, there appears to be no statistical difference in mortality outcome in theater for patients receiving deglycerolized blood (DRBC) as part of a massive transfusion when compared to patients receiving no DRBC as part of a massive transfusion. Additionally, there seems to be no significant difference between massive transfusions with DRBC and without DRBC in the development of complications for transfusion reaction, coagulopathy, renal failure, deep vein thrombosis (DVT), or respiratory failure.

Completed 23 March 2012

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Genitourinary (GU) Injury
Trauma Management (CPG ID: 42)

This CPG provides indications for and the procedures associated with the initial management of GU injuries sustained in combat casualties.

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EXECUTIVE SUMMARY

Between 2001 and 2011, a total of 501 soldiers sustained lower genitourinary injuries (GU) trauma, with a total of 729 injuries. The injury patterns are varied, including penile (20%), testicular (36%), scrotal (39%), and urethral (5%). Genitourinary surgery constitutes approximately 1.15% of procedures performed for combat injuries. During forward deployment, surgeons usually deploy without urology support. The most common procedures mirror the above injury patterns: testis (20.6%), bladder (18.8%), scrotum (17.7%), and kidney (13.5%). The single most common individual procedures performed were unilateral orchiectomy (394, 9.9%), suture of laceration of scrotum and tunica vaginalis (373, 9.4%), nephroureterectomy (360, 9.1%), and other suprapubic cystostomy (268, 6.8%). All deploying surgeons may be required to evaluate, stage, and surgically manage genitourinary, and gynecologic conditions.[1,2] Surgery on the male genitalia, bladder, and kidney were the most commonly required genitourinary operative procedures in deployed facilities, and so all surgeons should be familiar with the appropriate treatment of these injuries.

These guidelines provide direction for the identification of life threatening GU injuries, control of hemorrhage, establishment of urinary drainage, and the preservation of function where possible.

BACKGROUND

Management of GU injuries requires a systematic approach to imaging and treatment that adheres to established surgical and trauma principals. Critical to initial evaluation is to establish the hemodynamic stability of the patient, as treatment algorithms differ depending on the clinical situation. Stable patients are afforded a rigorous radiographic evaluation that identifies genitourinary sites of hemorrhage and injury and allows for the safe establishment of urinary drainage. Recognizing that intra-abdominal GU injuries are often associated with significant vascular and visceral injuries, unstable patients benefit from rapid surgical evaluation and hemorrhage control [2]. Preservation of as much tissue as possible, particularly when dealing with the external genitalia, should be an additional goal for far forward surgical units. Current combat care principles allow for multiple surgical evaluations along the path of evacuation to tertiary centers outside the theater of operations where tissue re-evaluation, wound irrigation, further debridement, and definitive treatment can occur.[3]

EVALUATION AND TREATMENT

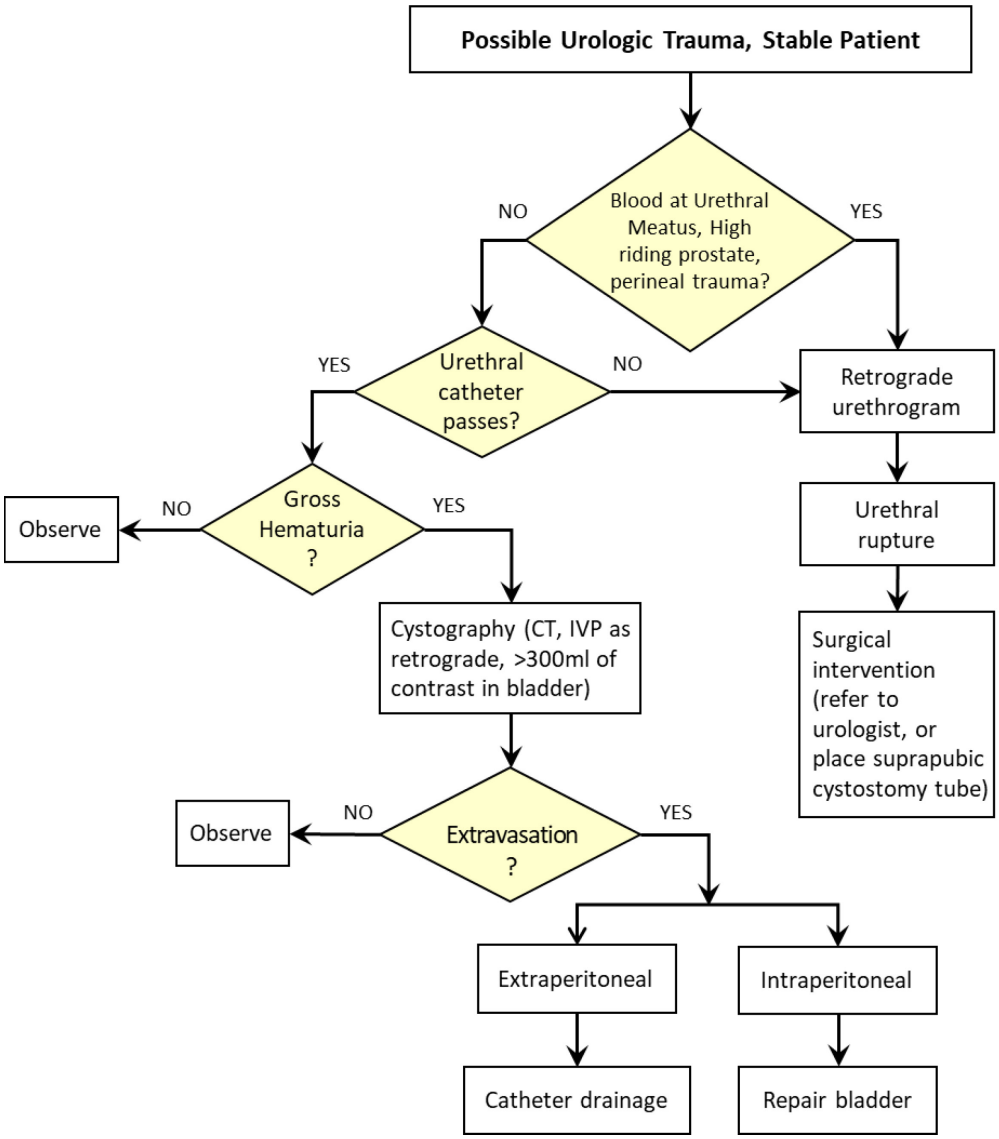
Ten percent of all combat casualties in current U.S. conflicts have GU injuries, which may be blunt, penetrating, or combined in nature. The extensive use of improvised explosive devices (IED) has resulted in a substantial number of penetrating injuries that include GU organs as part of a complex wounding pattern with trauma to the abdomen, pelvis, perineum, and extremities.[3,6-9] A significant reduction in kidney injuries has been noted in combat casualties wearing body armor.[10] Not surprisingly, given the mechanism of injury, the most commonly injured GU structures are the external genitalia and lower urinary tract (bladder and urethra).[6,11,12] A thorough trauma evaluation is therefore mandatory in all severely injured patients following proper Advanced Trauma Life Support (ATLS) based initial evaluation and management.

INITIAL EVALUATION

Severely injured patients typically warrant bladder drainage via catheter placement to facilitate urinary drainage and assist with hemodynamic monitoring via hourly assessment of urine output. Urethral injury should be suspected in the setting of scrotal hematoma, blood at the urethral meatus, or a high-riding prostate on initial rectal exam. In these situations, urethral integrity must be confirmed prior to catheter placement. Retrograde urethrography may also be necessary if there is any resistance to initial catheter placement (See Figure 1. Algorithm for Urologic Trauma below.) [4, 13] The inability to safely pass a catheter should prompt placement of a suprapubic catheter.

A urinalysis should be obtained after successful catheter placement and the presence of any gross hematuria should be immediately noted. Evaluation for renal injury is necessary in patients with gross hematuria or in patients with microscopic hematuria and an initial systolic BP < 90 mmHg (after they become hemodynamically stable); and in patients with mechanism of injury or physical examination findings suggestive of renal injury (i.e. rapid deceleration, rib fracture(s), flank ecchymosis, or a penetrating injury to the abdomen, flank, or lower chest).[13] The stability of the patient, operational environment and capabilities of the medical treatment facility will dictate which resources for radiographic and surgical evaluation are available at each echelon of care. The preferred imaging test to evaluate for renal and ureteral injury is an intravenous (IV) contrast enhanced computed tomography (CT) with delayed imaging.[13] If unavailable, "one shot" Intravenous Pyelography (IVP) can be performed. During the initial evaluation of patients with hematuria, it is important to note that the severity of hematuria (gross or microscopic) does not necessarily correlate to the severity of injury.[12] For example, it is possible to have minimal hematuria despite high grade renal injury such as disruption of the ureteropelvic junction, pedicle injuries, and segmental arterial thrombosis.[11] Conversely, low grade renal injury can result in ongoing gross hematuria. Thus, proper injury staging and high index of suspicion is critical regardless of hematuria severity. In cases of blunt renal trauma, most injuries can be managed conservatively. The grading scale is listed in Renal Injury in Appendix A: Urological Diagnosis and Treatments.)

Figure 1. Algorithm for Urologic Trauma



RENAL TRAUMA

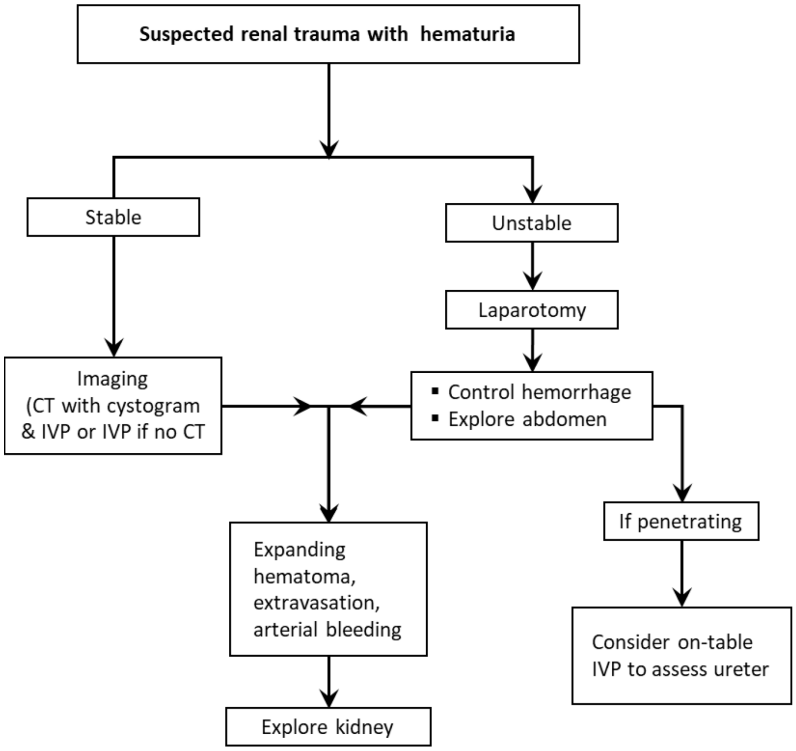
Patients with penetrating renal injuries often have associated injuries to other intra-abdominal organs that require laparotomy. Following principles of vascular injury in the retroperitoneum, all Zone 2 (perinephric) penetrating wounds should be explored. Generally, in the case of blunt injury a hematoma confined to the retroperitoneum can be left undisturbed; however persistent bleeding, expanding hematoma, or medial hematomas suggest a hilar, aortic, or caval injury and warrant direct evaluation.[4]

The decision as to repair or remove the damaged kidney at that time depends on the salvage-ability of the kidney and the ability of the patient to tolerate the procedure. Kidney preservation should be considered if possible. Nephrectomy may be required for the severely damaged kidney or the unstable patient. Verification of the presence of contralateral kidney by palpation or on-table imaging (IVP) should be determined prior to nephrectomy. High velocity kidney injuries are difficult to reconstruct and often result in nephrectomy. (See Nephrectomy in Appendix A: Urological Diagnosis and Treatments.) [14]

Ureteral injuries are nearly always secondary to penetrating trauma and a high index of suspicion based upon suspected bullet or fragment trajectory is necessary to avoid missing the diagnosis; IVP can be helpful if it can be performed in the operating room.[15,16] Hematuria may be absent and the only clue may be injuries to organs close to the path of the ureter or an unexplained rise in serum creatinine. If a ureteral injury is identified it may be repaired, but at a minimum should be 'tagged' for later repair and widely drained. Extracorporeal drainage ('stent to skin' or percutaneous nephrostomy- however, this is not widely available in theater)[15] is an option, with a small feeding tube or stent, if surrounding tissue destruction prevents early repair. (See Appendix A: Urological Diagnosis and Treatments.) [14]

An algorithmic approach to renal trauma management is presented in Figure 2 below.

Figure 2. Renal Trauma Algorithm



BLADDER TRAUMA

Bladder injuries may be secondary to blunt or penetrating trauma. Bladder rupture from blunt trauma is typically associated with pelvic fracture and results in gross hematuria. Thus, the combination of these two findings (hematuria + pelvic fracture) warrants retrograde plain film or CT cystography to evaluate for bladder injury.[13] Penetrating bladder injury must be excluded when the trajectory of the penetrating object is near the pelvis or lower abdomen.[18] Retrograde (plain film or CT) cystography should be performed prior to exploratory laparotomy if possible. However, when imaging is not possible prior to abdominal exploration, large intraperitoneal bladder injuries can be rapidly excluded by filling the bladder in a retrograde fashion with 200-300 ml of sterile saline or dilute methylene blue via the Foley catheter and inspecting for leakage of the fluid into the peritoneal cavity. Extraperitoneal injuries cannot be reliably excluded using this technique.

While intraperitoneal bladder rupture **must** be repaired, extraperitoneal rupture can be managed non operatively with Foley catheter drainage. Extraperitoneal injuries may benefit from immediate repair when pelvic fractures result in exposed bone spicules in the bladder lumen, concurrent rectal or vaginal lacerations may lead to fistula formation to the ruptured bladder, for bladder neck injuries that may not heal with catheter drainage alone, or when the patient is undergoing open repair of concurrent abdominal pelvic injuries in the stable patient.[13] Bladder repair is performed using a two layer closure with absorbable sutures and bladder catheter drainage. (See Bladder Injuries in Appendix A: Urological Diagnosis and Treatments.) It is important to note that bladder injury from penetrating trauma has a high incidence of concurrent rectal injury.[18]

URETHRAL TRAUMA

Urethral injuries are identified by retrograde urethrography. Blunt anterior urethral injuries should be stented with a urethral catheter when possible or diverted with a suprapubic cystostomy. Posterior urethral injuries, however, can be managed with suprapubic cystostomy alone.[13] A judicious attempt to realign the urethra endoscopically can be performed at subsequent operative evaluations when the patient is clinically stable several days following injury.[13] Penetrating anterior urethral injuries can be primarily repaired with fine absorbable suture over a urethral catheter when the degree of soft tissue injury/contamination is limited. However, when complex blast injury results in anterior urethral injury associated with significant soft tissue loss of the perineum and/or genitalia, urinary diversion alone (transurethral or suprapubic) is sufficient to facilitate urinary drainage until the patient can be evaluated by a urologist who can assist with the wound care and complex urethrogenital reconstruction frequently needed in these cases. This is most appropriately performed at a Role 4 or Role 5 facility following multidisciplinary planning.

EXTERNAL GENITALIA

With the rise in dismounted complex battle injuries from explosive devices in current combat operations and polytrauma involvement of the lower extremities, perineum, pelvis, and lower abdomen; greater attention has turned to the management of soft tissue injury to the external genitalia and urethra. Testicular injuries are easily missed due to small scrotal entry wounds in some cases and require a high index of suspicion when evaluating patients with significant blast injury. Bedside ultrasonography with vascular flow settings can easily identify testicular rupture and compromised vascular flow.[19] Initial operative management involves a thorough assessment of the injury sites with removal of wound contaminants and debridement of non-viable tissue. This is done in conjunction with copious, low-pressure irrigation of the wound.[5] (See External Genitalia Injuries in Appendix A: Urological Diagnosis and Treatments.)

In addition to arterial bleeding, vascular structures of the penis and scrotum should be addressed on initial surgery, specifically, the corpora cavernosa, corpus spongiosum, and bilateral testes. Lacerations to the corpora

cavernosa can be closed with absorbable suture taking care to avoid the dorsal neurovascular structures. Aggressive over sewing of the corpus spongiosum, however, should also be avoided in favor of site specific closure to its tunical covering reducing risk of ischemic changes distal to the injury site in these complex wounds.[19,20] Patients with penetrating scrotal wounds or evidence of testicular rupture on exam should undergo scrotal exploration. Ruptured testes are managed with irrigation and debridement of non-viable seminiferous tubules. The tunica albuginea is then closed and returned to the scrotum.[13] A tunica vaginalis flap can be used to close the defect when there is insufficient tunica to obtain a tension free closure over the exposed tubules. [21] A delay in managing a testicular injury is acceptable when the patient is too unstable or there is insufficient expertise to manage it at initial exploration. Every attempt should be made to salvage viable testicular tissue especially when both testicles are involved or a unilateral orchiectomy is required. The injured testis should be wrapped in saline soaked gauze and protected with multiple layers of additional dressing. A vacuum assisted dressing is NOT appropriate if the tunica is left open. All findings should be documented and communicated to the next echelon of care.

The superficial fascia and skin layers of the penis can and should be left open following high energy trauma. Loose approximation of these layers with interrupted suture allows continued tissue evaluation and additional wound debridement. A moist gauze or negative pressure dressing is appropriate. Alternatively, Penrose drains can be placed between loosely approximated interrupted sutures. In cases where scrotal closure is impossible, the testis can be covered with a non-adherent dressing followed by a negative pressure dressing. Creation of a sub dermal thigh pouch is rarely necessary during early surgical care.

With the recent introduction of female combatants to all roles in the military, GU injuries in female patients have risen. Of the nearly 1500 service members in Operation Enduring Freedom and Operation Iraqi Freedom between 2001 and 2013, 1.3% were female. Injuries described in female service members thus far include bladder injury, vulvar injury, vaginal injury, bladder and perineal injury. Currently there is limited evidence-based direction in the management of these injuries. Initial care should focus on good exposure of the injured tissue with a complete examination to include the vaginal vault, urethra, and meatus with low pressure irrigation and judicious debridement of devascularized tissue. Limited debridement should be practiced around the clitoris favoring repeat examinations in the operating room with intervention as needed. This new injury pattern is being prospectively tracked to best ensure appropriate care.[22,23]

AEROMEDICAL EVACUATION CONSIDERATIONS

As for all postoperative and litter bound patients, Deep Venous Thrombosis prophylaxis should be considered. See The Prevention of Deep Venous Thrombosis – Inferior Vena Cava Filter CPG, 02 Aug 2016 (ID: 36).

- Vibration and increased tissue edema in flight will increase pain. Ensure adequate en-route pain control by ordering breakthrough pain medications.
- Do not remove drains within the 12 hours prior to movement.
- Consider filling Foley Catheter balloon with water to reduce expansion in flight.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients with GU injury (kidney, ureter, bladder, testicles/ovaries, penis, external genitalia)
- All trauma patients with hematuria.

INTENT (EXPECTED OUTCOMES)

1. All patients in the population of interest have a documented GU exam.
2. Patients with renal trauma undergo attempted renal salvage unless hemodynamically unstable.
3. Patients with hematuria are evaluated for GU injury (imaging if stable, surgical exploration if unstable).
4. Patients with blunt trauma, pelvic fracture and hematuria are evaluated for bladder injury with cystography.
5. Patients with suspected urethral injury or blood at the meatus undergo retrograde urethrography.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with documented GU exam.
2. Number and percentage of patients with renal trauma who are hemodynamically stable on admission to Role 2 or 3 who undergo nephrectomy at the same role of care.
3. Number and percentage of trauma patients with hematuria who are evaluated for GU injury (imaging if stable, surgical exploration if unstable).
4. Number and percentage of patients with blunt trauma, pelvic fracture and hematuria who are evaluated for bladder injury with cystography.
5. Number and percentage of patients with suspected urethral injury or blood at the meatus who undergo retrograde urethrography.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Division.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: UROLOGICAL DIAGNOSIS AND TREATMENTS

Diagnosis	Treatment
Hematuria	• Place Foley catheter during trauma assessment unless contra-indicated such as blood at the urethral meatus or other evidence of urethral injury (pelvic fracture). • Perform a retrograde urethrogram (RUG) before attempted catheterization when there is concern for a urethral injury. • RUG – Obtain an oblique plain film of the pelvis with the patient's bottom leg flexed at the knee and the top leg straight. Severely injured patients or those with suspected spine fractures can be left supine**.** Alternately, C-arm or fluoroscopy can be used. A 12Fr Foley catheter or catheter tipped syringe is inserted into the fossa navicularis, the penis placed on traction, and 20 mL of undiluted water soluble contrast injected under gentle pressure. Images are obtained. The study is considered normal only if contrast enters the bladder without extravasation. • For an anterior urethral injury, plan on repair in the operating room (OR). For a posterior urethral injury, a suprapubic catheter can be placed in the OR, or percutaneously in the emergency department (ED) for patients who do not need surgery and an appropriate kit is available. For partial urethral disruption by RUG, a single attempt with a well-lubricated catheter may be attempted by an experienced team member in the ED. • If the catheter passes, and gross hematuria is noted, proceed with GU diagnostic evaluation for bladder injury or a renal/ureteral source. CT scan with delayed images and CT cystogram are appropriate imaging studies (see technique description following).

Renal Injury	• Clinicians should perform diagnostic imaging with intravenous (IV) contrast enhanced computed tomography (CT) with delayed imaging in stable blunt trauma patients with gross hematuria or microscopic hematuria and systolic blood pressure < 90mmHG or in any stable trauma patients with mechanism of injury or physical exam findings concerning for renal injury (e.g., rapid deceleration, significant blow to flank, rib fracture, significant flank ecchymosis, penetrating injury of abdomen, flank, or lower chest).
	• **Renal Injury Grading**
	  • Grade 1: Sub-capsular hematoma
	  • Grade 2: Small parenchymal laceration
	  • Grade 3: Deeper parenchymal laceration without entry into collecting system
	  • Grade 4: Laceration into collecting system with extravasation; vascular injury with contained hemorrhage
	  • Grade 5: Shattered kidney or renal pedicle avulsion
	• Hemodynamically stable patients can be managed without surgical exploration in most cases.
	• Hemodynamically unstable patients with no or transient response to resuscitation should have immediate intervention.
	• Vascular repair is indicated for salvageable kidneys with renal artery or vein injury.
	• Ureteral stenting may be needed for enlarging urinoma or persistent urinary extravasation with fever, pain, ileus, fistula, or infection.

Renal Exploration During Abdominal Operation	• Stable perirenal hematomas found at time of exploration should not be routinely opened. • Penetrating injuries to retroperitoneal zone 2 should be explored. • Renal exploration should be performed at time of laparotomy for persistent bleeding, expanding hematoma, or a central hematoma suggesting a renal hilum injury
Nephrectomy	• Total nephrectomy is immediately indicated in extensive renal injuries when the patient's life would be threatened by attempted renal repair. • A common surgical approach is a lateral to medial mobilization of the kidney to expose the renal pedicle after incision of the peritoneal attachments of the colon to the lateral wall. While there is insufficient data to recommend initial vascular control of the renal pedicle through a mesentery window prior to exploration, this remains an acceptable principle for isolated renal surgery. • Damage control by packing the wound to control bleeding and attempting to correct metabolic and coagulation abnormalities, with a plan to return for corrective surgery within 24 hours is an option.

Diagnosis	Treatment
Renal Repair and Partial Nephrectomy Principles	• Non-surgical management can result in renal preservation even with high grade injuries. Renal repair is appropriate after gaining hemorrhage control and hemodynamic stability for potentially salvageable kidneys identified during exploration. • **Technique**: Complete renal exposure, debridement of nonviable tissue, hemostasis by individual suture ligation of bleeding vessels, watertight closure (absorbable suture), drainage of the collecting system, and coverage/approximation of the parenchymal defect. • Perform partial nephrectomy if reconstruction is not possible: the collecting system must be closed and the parenchyma covered with fat or omentum. Consider the use of hemostatic agents and tissue sealants if available. • Place ureteral stent for persistent urinary extravasation.
Ureteral Injuries	• Identification of ureteral injury requires a high index of suspicion. It should be evaluated with IV contrast enhanced CT with delayed imaging or direct inspection during laparotomy if preoperative imaging is not available. • Ureteral contusions can be managed by stenting or judicious excision of the injured area with primary anastomosis depending on its severity. Simple ureteral lacerations should be closed primarily. • Complete transections of the ureter proximal to the iliac vessels can be repaired using a tension free, end to end, spatulated anastomosis over a ureteral stent. Transections distal to the vessels should be managed with a ureteral reimplantation over a stent. A psoas hitch or Boari flap may be necessary in some cases. • In cases of inadequate ureteral length to re-anastomose or hemodynamic instability of the patient intraoperatively, a pediatric feeding tube or open ended ureteral catheter may be placed in the proximal ureter and brought out through the skin and placed to closed drainage. Reconstruction of the ureter can then be performed at a future date. • An ureteropelvic junction (UPJ) avulsion injury should undergo re-anastomosis of the ureter to the renal pelvis over a stent. • A drain should be considered after ureteral repair.
Bladder Injuries	• Perform retrograde cystography in patients with gross hematuria and a mechanism concerning for bladder injury, finding on exam or imaging concerning for bladder rupture, or pelvic ring fracture. • Retrograde cystography can be done by CT or plain film. For CT cystogram use diluted Conray to reduce scatter artifact from the contrast. A minimum of 300 ml is needed for an adequately study. Plain film images should include a scout film and an AP image with or without oblique views both with the bladder full and again after it is drained. • **Extraperitoneal** extravasation of contrast can be managed with Foley catheterization alone in most cases. Open repair is indicated for complicated ruptures that include pelvic fractures with exposed bone spicules in the bladder and concurrent rectal or vaginal lacerations that may lead to fistula formation. Patient's undergoing exploration for other indications that are appropriately stable and those with significant bladder neck involvement should be considered for closure. A transvesical approach can reduce disruption of the pelvic hematoma. • **Intraperitoneal** rupture requires open repair, two-layer closure with absorbable suture, and perivesical drain placement. A large caliber urethral catheter without suprapubic catheter is usually sufficient for bladder drainage. Patients with complex lower extremity, pelvic, or perineal injuries and those requiring prolonged immobilization may benefit from suprapubic catheter drainage as well. • Follow up cystography should be performed prior to catheter removal

Diagnosis	Treatment
Urethral Injuries	• **Diagnosis**: A RUG should be performed in any case of suspected urethral injury. For partial urethral tears, a single attempt at urethral catheterization with a well lubricated catheter may be attempted by an experienced provider. • **Anterior urethral injuries**: Primary repair of uncomplicated penetrating injury to the anterior urethra may be performed using fine absorbable sutures with careful mucosal to mucosal apposition over a urethral catheter. Immediate repair should not be performed in the setting of extensive tissue damage or urethral loss, patient instability, or surgeon inexperience. Bleeding from the corpus spongiosum can be controlled with site specific fine absorbable suture. Bladder drainage should be established by urethral catheterization or suprapubic drainage. • **Posterior urethral injuries**: These injuries are typically associated with pelvic fractures or deep penetrating trauma. Suprapubic urinary drainage with delayed reconstruction is the accepted treatment for the majority of cases. Endoscopic alignment may be attempted within the first several days after injury in a hemodynamically stable patient. Aggressive attempts at realignment should be avoided.
External Genitalia Injuries	• The primary goals in the management of genital injuries are hemorrhage control and tissue preservation. • Hemorrhage can occur from small arteries on the dorsal penile shaft and/or the spermatic cord. These vessels can be managed with precise cautery. • Large volume, low pressure, irrigation with normal saline should be performed with each surgical intervention. Delayed wound closure is appropriate for significant injuries with considerable tissue damage. Negative pressure wound dressings are well tolerated but often require creative placement techniques when applied to the genitalia. A non-adherent silicone or hydrophilic white foam dressing can be used to cover exposed testicles or freshly repaired corporal tissue when using a negative pressure dressing. • **Penile injury** may include the corpus spongiosum or corpus cavernosa, and can result in continued hemorrhage. These can be repaired by approximation of the tunical margins with absorbable sutures in a hemostatic fashion following irrigation and debridement of necrotic or devitalized tissue. • The glans is well vascularized and can generally be closed with interrupted absorbable suture. • **Scrotal injuries** are managed in a similar fashion as other soft tissue wounds. Small penetrating injuries can result in significant testicular damage. There should be a low threshold for surgical exploration in these cases. The scrotum should undergo irrigation and debridement with primary or delayed closure. Widely spaced absorbable suture and a Penrose drain can be used in lieu of a negative pressure dressing when delayed closure is required. • **Testicle injuries** can be diagnosed with physical exam or scrotal ultrasound. CT or sonography may also show evidence of foreign bodies or air in the scrotum or abnormality of one or both testes. Equivocal cases should be explored. Necrotic testicular tissue should be debrided and the capsule closed with absorbable suture. A tunical vaginalis flap can be used when the tunica albuginea is deficient for closure.

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Global Snake Envenomation Management (CPG ID: 81)

Guide providers in the evaluation and treatment of patients after snake bites.

Rapid Update (Jun 2023): removal of Promethazine recommendation in accordance with DHA Policy Memo 23-001 Discontinuation of Injectable Promethazine Usage at MTFs.

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BACKGROUND

Snakebite, recently declared a neglected tropical disease and global health priority by the World Health Organization (WHO), results in an estimated 2.5 million envenomations, 138,000 deaths and over 500,000 cases of permanent disability worldwide every year.[1–10] Snake, spider, and scorpion envenomations are a common environmental and occupational hazard for military forces worldwide.[11–46] The consequences of an envenomation range from mild local effects to permanent disability or death, and the outcome is largely determined by the time to antivenom treatment and the level of training of the medical providers involved.

Once an envenomation has occurred, the provider and patient are racing against the clock to neutralize active venom components before extensive damage has occurred. Necrosis caused by cytotoxic venoms cannot be reversed, but it can be prevented by early antivenom administration or arrested before further damage can occur in cases of late antivenom treatment.[1,7,47,48] Hemotoxic venoms can induce coagulopathies within an hour of the envenomation which is quickly followed by a standard progression of worsening local and systemic external and internal bleeding. Neurotoxic venoms can act rapidly and be fatal. Africa is one of the few places in the world with snakes like the black mamba that are capable of killing a human within one hour due to direct effects of the venom, and most patients with mamba envenomation who are not rapidly treated with antivenom will die within 2 - 6 hours from respiratory arrest.[1,49] When a neurotoxic bite occurs, rapid antivenom administration prior to the onset of respiratory muscle weakness can arrest the progression of descending paralysis before serious systemic manifestations develop.[1,50,51] Every hour wasted between bite and antivenom administration is strongly associated with sharp increases in mortality and the development of chronic or permanent sequelae including amputation, disfigurement, PTSD, blindness, kidney injury, infections, and partial or complete loss of function of the bitten limb.[4,7,8,52–58]

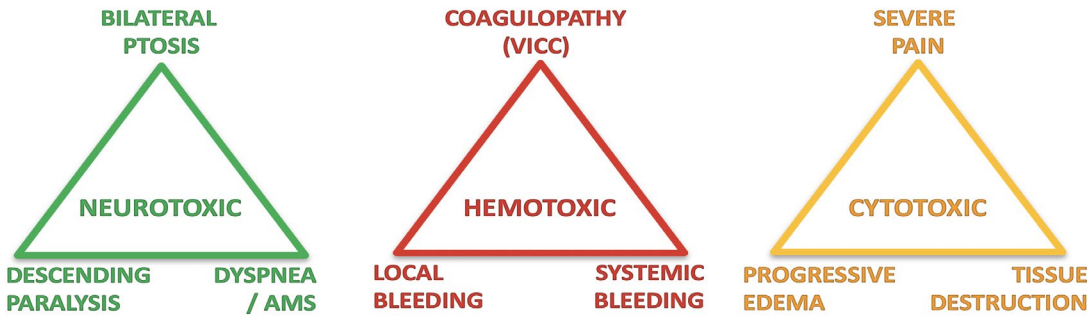
This CPG will cover the continuum of snakebite care for snake envenomations in all combatant commands.

GENERAL PRINCIPLES OF SNAKEBITE MANAGEMENT

Don't try to ID the snake. Snake identification is unreliable and should not be purposely attempted. DO NOT attempt to catch or kill the snake; treatment is clinical and the snake species does not need to be identified.

There are 3 major clinical syndromes of snakebite envenomation worldwide and 3 major signs and symptoms of each. All dangerous snakes capable of injuring or killing a human will produce at least one sign or symptom from at least one of the 3 major snakebite syndromes (neurotoxic, hemotoxic, and cytotoxic). Specific antivenoms required will vary regionally but the major triads are applicable globally.

Figure 1. Snakebite Clinical Triads



CLINICAL PEARLS ON SNAKEBITES AND ANTIVENOM TREATMENT

1. **Not all snakes are venomous and not all snake bites result in snake envenomations!**

   Most snake species pose no danger to humans, and only ~600 of the >3500 snake species worldwide are considered potentially dangerous to people. However, dangerous species are often drawn to human habitations in search of food, water, or shelter and envenomations are very common in the developing world.

2. **Roughly 25% of bites from dangerously venomous snakes are harmless "dry bites" where no venom is injected!**

   a. This means that even if you know that the snake which bit your patient is a dangerous species, it does not mean that they will require antivenom treatment. While the exact percentage varies by species, on average 25% of bites from venomous snakes are considered "dry bites" that are designed to scare away a potential threat that is too big to eat without wasting venom. Venom is metabolically expensive to produce and snakes will try to conserve their venom for potential prey items whenever possible.

   b. The dry bite phenomenon explains why many people believe that useless or potentially harmful interventions such as venom extractors or black stones are effective: these patients appear to have recovered miraculously thanks to the treatment they applied but in reality, they were never sick to begin with!

3. **Snakebite treatment should always be determined by the clinical presentation and evolution of signs and symptoms in the patient rather than the identity of the snake that bit them!**

   a. Remember that many snakebites are likely to have resulted from harmless snakes and that roughly 1/4 people bitten by a truly dangerous species are likely to be fine because of the dry bite phenomenon. Many dangerous species have harmless mimics and vice versa. Do not attempt to identify snake species if you are not a herpetologist. **Identifying the snake species will not change your patient care!**

   b. Do not treat patients simply based on the fact that they were bitten by a dangerous snake species.

   c. Always treat snakebite patients based on the signs and symptoms they develop. A patient who hands you a dead mamba and develops no signs or symptoms of envenomation does not require antivenom unless they develop progressive signs and symptoms of an envenomation. Conversely, a patient who has no recollection of a snakebite or believes that the species responsible was harmless will require treatment for an envenomation if they subsequently develop progressive swelling, systemic bleeding, or other signs of the three major snake envenomation triads.

4. **There are no absolute contraindications to antivenom for patients with symptomatic snake envenomations. The high risk of permanent damage posed by untreated venom in the body is far greater than the low risk of anaphylaxis associated with high-quality modern antivenoms.**

   a. Antivenom administration at the earliest possible opportunity is the gold standard of snakebite care and most effective way to reduce the risk of death or permanent disability in these patients.

   b. Early antivenom administration in the field at or near the point of injury may resolve the underlying envenomation before any serious systemic signs or symptoms develop.

   c. Ignore the packaging and manufacturer insert and treat according to the guidelines outlined in this CPG.

d. Dosing and administration of recommended antivenoms in this CPG can vary significantly between products; refer to the specific instructions included later in this CPG for whichever product you have on hand.

e. Antivenom may be given by IV or IO injection or infusion.[54,59] An IV is preferable but IO is an acceptable alternative and should not influence the efficacy of the medication.

f. DO NOT give antivenom by IM or SQ injection, even if packaging says you can. The serum concentrations of antivenom given by IM or SQ injection will never achieve more than a fraction of the serum concentrations rapidly achieved from the intravascular route.

g. DO NOT administer test doses of antivenom to check for hypersensitivity prior to giving the full dose. Test doses have no predictive value for identifying patients with hypersensitivity and waste both time and antivenom.[60–63]

h. **Antivenom dosage is not weight-based** and there is no difference in dosing between adults and children.

i. **The dose of antivenom needed is proportional to the dose of venom injected into the patient**. The quantity of venom injected into the patient corresponds to the severity of the envenomation syndrome(s).

j. Additional antivenom should be given as many times as needed until control of envenomation is achieved.

k. Overdosing antivenom is not a concern during the active treatment phase, and the worst-case scenario is an allergic reaction. If a patient develops a reaction to large doses, it will most likely manifest as a late reaction called serum sickness (fever, rash, arthralgia, etc.) 1 - 3 weeks later and can be managed with antihistamines or steroids if the patient is uncomfortable. Serum sickness may be uncomfortable but is not life-threatening.

5. **Establish a timeline and trend changes over time. Serial assessments and documentation are essential because the resolution of certain clinical findings will be used to determine when the right dose of antivenom has been given. At a minimum always document the following:**

   a. Time and date when bite occurred

   b. Time elapsed from bite to presentation under your care (record as minutes, hours, days, etc.)

   c. Time when the first dose of antivenom is given (defined as Hour 0, written as H0)

   d. Always repeat a complete snakebite assessment at hours 2, 4, 6, 12, and 24 (H2, H4, H6, H12, H24) since the first dose of antivenom was given in order to trend the clinical evolution of the syndrome over time.

6. **Snakebites are clinically dynamic emergencies and can change dramatically until control has been achieved.**

   Patients may present with one syndrome initially and develop signs and symptoms of another later on (for example, a patient who presents with local pain and mild swelling at H0 could develop local bleeding or ptosis at H4). Always look for signs and symptoms of all three triads when reassessing and redirect your treatments if needed according to the clinical evolution observed in your patient.

UNIVERSAL APPROACH TO THE SNAKEBITE PATIENT

INITIAL PRIORITIES

1. Airway, breathing, circulation, and rapid antivenom administration are the critical priorities during stabilization and treatment of a snakebite casualty.

    a. Assess ABCs; identify and address any immediate life threats before proceeding.

    b. Refer to the Sudden Collapse Syndrome Treatment Protocol for specific instructions on stabilization and management of patients who develop rapid onset shock ± angioedema, altered mental status, systemic bleeding, and/or diarrhea within the first 30 minutes after a snakebite

    c. Treat emergent secondary issues that may be present (such as anaphylaxis or hypovolemic shock) according to standard clinical protocols.

    d. Establish IV or IO access in a non-bitten limb before proceeding.

2. ***DO NOT apply constricting bandages or tourniquets*** as these may worsen local tissue injury and increase the risk of permanent disability.[64–66]

    If a tourniquet is already in place, do not remove it until you are ready to treat and resuscitate the patient as a rapid decompensation can occur.[67,68] When removing a tourniquet do so sequentially (loosen for several seconds - tighten - observe - repeat) over 20 - 30 mins; if symptoms develop at any time administer antivenom and wait at least 30 minutes before resuming tourniquet release. Ideally, this should not be done until antivenom is available but prolonged evacuation times without antivenom may necessitate the risk of earlier removal to prevent limb death. Refer to the Joint Trauma System Tactical Combat Casualty Care (TCCC) Guidelines for tourniquet conversion in these settings.

3. If and when conditions allow, minimize patient activity, and loosely immobilize bitten limb to reduce movement without constricting tissues.

    a. If antivenom is not available onsite, choose whichever evacuation option will safely get your patient to the antivenom in the shortest amount of time. This includes allowing the patient to walk to help when needed.

    b. If conditions allow during transport, maintain the bitten limb in a position of comfort that is elevated above the level of the heart.

    c. Once the patient has arrived at the clinic and can be placed in a bed, aggressively elevate the bitten limb (aim for a minimum 60º angle in a supine patient if possible and tolerated by patient) to reduce oncotic pressure on swollen tissues.

4. Evaluate for specific signs and symptoms of snake envenomation. See Table 1 and refer to specific criteria for initial antivenom treatment and repeat doses for additional information.

FOCUSED ASSESSMENT AND EXAMINATION

Perform a physical examination and history focused on identifying signs and symptoms of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes.

1. Determine how long ago the bite occurred. Circle the site of the bite wound and write the specific time that it occurred with a permanent marker on the patient
2. Do not rely on fang marks to assess the possibility of a bite or envenomation. Snakebites can leave punctures, multiple lacerations, or even no obvious fang marks whatsoever.
3. Rapid examination for signs of **pain, swelling, or tissue destruction (cytotoxic syndrome).**
   Separately mark the leading edge of both pain (dashed line) and edema (solid line) with a permanent marker and record time of observation next to each line
4. Rapid examination for signs of **local or systemic bleeding (hemotoxic syndrome)**
   a. Inspect the bitten limb for persistent local bleeding > 30 mins from the bite wound (if visible) or other lesions.[1,70–72]
   b. Inspect the molar gingiva and other mucosa for signs of systemic bleeding.[1,69,70]
5. Rapid examination for signs of **neuromuscular weakness (neurotoxic syndrome)**
   a. Evaluate respiratory muscle weakness by single breath count testing[72] and repeat periodically to trend improvement or deterioration in respiratory function over time.
      - The single breath count (SBC) test requires no equipment to perform and is easily performed in austere settings:

        Ask the patient to take a deep breath and count as high as possible in their normal speaking voice without taking another breath. Demonstrate the test to the patient, then have them repeat it and record the highest number reached.
        - SBC correlates closely with spirometry.
        - Normal SBC is approximately 50 and SBC < 20 is associated with the need for mechanical ventilation.
      - If spirometry is available, this can be used in place of the single breath count test by evaluating the negative inspiratory force (NIF) and/or forced vital capacity (FVC).
        Conduct gross assessment and pay particular attention to the following:
        - Signs and symptoms of descending flaccid paralysis: Ptosis, diplopia, neck flexor muscle weakness, bulbar weakness, etc.[1,54,73]
        - Signs and symptoms of parasympathetic / cholinergic crisis: SLUDGE mnemonic - Salivation, Lacrimation, Urination, Defecation, GI distress, Emesis
   b. Perform and/or check the clinical laboratory tests listed below (if available).

UNSTABLE PATIENTS

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

1. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
2. Intubate for airway edema not rapidly responsive to epinephrine
3. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
4. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

LAB TESTS

Advanced laboratory tests include:

- Complete Blood Count (CBC)
- Hemoglobin (Hb) or Hematocrit (HCT) if no CBC but separate testing for either Hb or HCT is available
- Prothrombin Time (PT), Partial Thromboplastin Time (PTT), and International Normalized Ratio (INR)
- Fibrinogen
- Comprehensive Metabolic Panel (CMP)
- Creatine Kinase (CK)

Simple coagulation test for austere environments: Use the Whole Blood Clotting Test (WBCT) as described in Appendix A to diagnose and monitor coagulopathy if advanced labs not available

TRANSPORT FACTORS

1. If the patient is being medically evacuated from the field or between roles of care, confirm that the receiving facility has an adequate supply of the appropriate regionally specific antivenoms listed in this CPG to ensure treatment coverage against local species of concern.

   NOTE: *Evacuation is not an alternative to antivenom administration. A patient whose snakebite warrants evacuation will require antivenom. The earlier it is given the greater the chance of full recovery without permanent disability. DO NOT delay administration of antivenom in the field to a patient with an envenomation.*

2. If clinical evidence of envenomation is present and treatment is occurring in a hospital setting, always admit to a bed with continuous vital sign monitoring if available. If no initial clinical evidence of envenomation, admit for 24 hours for observation. If treating in the field, continuously monitor patient trends for signs of progression, improvement, or deterioration.
3. Symptoms should be expected within 24 hours; if the patient is completely asymptomatic after 24 hours then they most likely received a dry bite and can be discharged. See Discharge Criteria.

INITIAL ANTIVENOM TREATMENT

Antivenom dosing, preparation, and administration recommendations vary by product. Coverage, initial dosing, preparation, and administration of antivenoms are included in this CPG. Refer to guidelines for the specific product prior to administering the antivenom.

Table 1. Simplified universal diagnosis and treatment criteria for snakebite worldwide

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc.); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	*Additional doses if:* *persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until indications of improvement begin to appear* (↑SBC, ↑LOC, ↑strength, etc.)	*Additional doses if:* *persistence, resumption, or new onset of any active external or internal bleeding* ***OR*** *S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT*	*Additional doses if:* *significant increase in edema (such as beyond major joint)* ***OR*** *significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)*

S/Sx = Signs & Symptoms; SBC = Single Breath Count Test; LOC = Level of Consciousness; WBCT = Whole Blood Clotting Test

Table 2. All Combatant Commands – First Line Antivenoms

First Line Antivenoms for All Combatant Commands		
AFRICOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage against All Three Major Syndromes (Neurotoxic/Hemotoxic/Cytotoxic)** **Sub-Saharan Africa:** Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known or unknown species - *POLYSERP-P: Initial dose = 6 vials / Additional doses = 2 vials as needed* **North Africa:** Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known or unknown species - *POLYSERP-M: Initial dose = 6 vials / Additional doses = 2 vials as needed*	
AFRICOM Abbreviations	**POLYSERP-P** = POLYSERP PAN-AFRICA **POLYSERP-M** = POLYSERP MENA	
CENTCOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage against All Three Major Syndromes (Neurotoxic/Hemotoxic/Cytotoxic)** **CENTCOM**: Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known* or unknown species - *POLYSERP-M: Initial dose = 6 vials regardless of severity / Additional doses = 2 vials as needed* **CENTRAL ASIA**: *If patient has a confirmed *Gloydius halys* bite (rare!), use SIOBP-G as 1st line if available. If unavailable or unconfirmed ID give POLYSERP-M - SIOBP-G: *Initial dose = 2 vials / Additional doses = 2 vials as needed*	
CENTCOM Abbreviations	**POLYSERP-M** = POLYSERP MENA **SIOPB-G** = *Gloydius halys* monovalent	
EUCOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage Against All Three Major Syndromes (Neurotoxic/Hemotoxic/Cytotoxic)** **UK or Scandinavia**: Broad-spectrum coverage all neurotoxic/hemotoxic/cytotoxic syndromes from European *Vipera* species - *VIPERATAB (1st line): Initial dose = 2 vials (one box), additional doses = 1 – 2 vials as needed* - *VIPERFAV (2nd line): Initial dose = 1 – 2 vials, additional doses = 1 vial as needed* **Outside UK/Scandinavia**: Broad-spectrum coverage all neurotoxic/hemotoxic/cytotoxic syndromes from European *Vipera* species - *VIPERFAV (1st line): Initial dose = 1 – 2 vials, additional doses = 1 vial as needed* - *VIPERATAB (2nd line): Initial dose = 2 vials (one box), additional doses = 1 – 2 vials as needed*	
EUCOM Abbreviations	**VIPERFAV** = VIPERFAV **VIPERATAB** = ViperaTAb	
INDOPACOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage Against Neurotoxic Syndrome** **Southeast Asia**: Broad-spectrum for all neurotoxic - *TRC-NPAV: Initial dose 10 vials* *Additional doses = 5 vials as needed* - TRC-*NPAV* is the 1st line for all neurotoxic bites in SE Asia outside of the circumstances listed below: **Marine environments**: Sea snake envenomations - *CSL-SS: Initial dose = 3 vials* *Additional doses = 1 vial as needed* **Maluku/West Papua islands**: Neurotoxic - *CSL-P: Initial dose = 3 vials* *Additional doses = 1 vial as needed*	**First Line Antivenoms with Regional Coverage against Hemotoxic and/or Cytotoxic Syndromes** **Southeast Asia**: Broad-spectrum for all hemotoxic/cytotoxic (1st line in SE Asia) - *TRC-HPAV: Initial dose = 10 vials, additional doses = 2 vials as needed.* TRC-HPAV is the 1st line for all hemotoxic/cytotoxic bites in SE Asia outside of circumstances listed below: **Korean Peninsula/Eastern China**: Viper envenomations (Cytotoxic +/- Hemotoxic) Korean Mamushi species (*Gloydius brevicaudus, G. ussuriensis, G. intermedius*) - KOVAX-AKA*: Initial dose = 1 - 2 vials, additional doses = 1 vial as needed* **Taiwan / Se China / N Vietnam / Laos:** Sharp-nosed viper (*Deinagkistrodon acutus*) - NIPB-SNV*: Initial dose = 2 vials, additional doses = 1 vial as needed* **Japan**: Viper envenomations (Cytotoxic +/- Hemotoxic) If Japanese HABU (*Protobothrops spp.)* envenomation: - CSTRI-HABU*: Initial dose = 1 -2 vials, additional doses = 1 vial as needed* If Japanese Mamushi (*Gloydius blomhoffi*) envenomation:

First Line Antivenoms for All Combatant Commands		
	Eastern China/Taiwan: Neurotoxic - *NIPM-NBB: Initial dose = 5 vials* *Additional doses = 5 vials as needed*	- CSTRI-MAMU*: Initial dose = 1 -2 vials, additional doses = 1 vial as needed* **Japan/China/ N & S Korea/Vietnam/E Russia**: Rhabdophis spp. - Hemotoxic without Cytotoxic Spontaneous bleeding develops within several days of bite without cytotoxicity. - *JSI-AYA: Initial dose = 1 -2 vials, additional doses = 1 vial as needed*
INDOPACOM Abbreviations	**TRC-NPAV** = Neuro Polyvalent Antivenom **CSL-P** = CSL Polyvalent **CSL-SS** = CSL Sea Snake **NIPM-NBB** = Naja atra - Bungarus multicinctus Bivalent	**TRC-HPAV** = Hemato Polyvalent Antivenom **KOVAX-AKA** = Agkistrodon Mamushi Antivenom **JSI-AYA** = Anti-Yamakagashi Antivenom **CSTRI-HABU** = Kaketsuken Habu Antivenom **CSTRI-MAMU** = Kaketsuken Mamushi Antivenom **NIPM-SNV** = Sharp-nosed Viper Monovalent
NORTHCOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage Against Neurotoxic Syndrome** **United States**: Coral snake envenomations *- Initial 3-5 vials NACSA, additional doses not needed if 5 vial initial dose given* **United States/Canada**: Pit viper envenomations* *- CROFAB: Initial dose = 4-6 vials, Additional doses = 4-6 vial as needed* *- ANAVIP (rattlesnakes only): Initial dose = 10 vials, Additional doses = 10 vials as needed* *Follow unified treatment algorithm (Lavonas 2011)	**First Line Antivenoms with Regional Coverage against Hemotoxic and/or Cytotoxic Syndromes** **United States/Canada**: Broad spectrum coverage all hemotoxic/cytotoxic syndromes* Any pit viper envenomation (rattlesnake, copperhead, cottonmouth): - *CROFAB: Initial dose = 4-6 vials, additional doses = 4-6 vials as needed* Rattlesnake envenomations only: - *ANAVIP: Initial dose = 10 vials, additional doses = 10 vials as needed* NOTE: Anavip is only indicated by FDA for rattlesnake envenomations; not for copperheads or cottonmouths at this time; however, it is likely effective against all North American pit vipers. Follow *Unified treatment algorithm for the management of crotaline snakebite in the United States* (Lavonas et al. 2011) for specific dosing and management guidelines on pit viper bites.
NORTHCOM Abbreviations	**CROFAB** = CroFab **ANAVIP** = ANAVIP **NACSA** = North American Coral Snake Antivenin	
SOUTHCOM 1st Line Antivenoms	**First Line Antivenoms with Regional Coverage Against Neurotoxic Syndrome** **Central America:** Neurotoxic polyvalent - *BIOCL-COR: Any severity = initial 10 vials Additional 5 vials as needed* **South America**: Neurotoxic polyvalent - *INS-AAP: Any Severity = 10 vials Additional 5 vials as needed*	**First Line Antivenoms with Regional Coverage Against Hemotoxic and/or Cytotoxic Syndromes** **Central and South America**: Broad-spectrum all hemotoxic/cytotoxic syndromes - *BIOCL-AVT: Initial dosing of this antivenom is based on severity* *- Mild – moderate: Initial dose = 10 vials BIOCL-AVT Additional doses = 5 vials as needed* *- Severe: Initial dose = 15 vials BIOCL-AVT Additional doses = 5 vials as needed*
SOUTHCOM Abbreviations	**BIOCL-COR** = CORALMYN **INS-AAP** = Antiveneno Anticoral Polivalente **BIOCL-AVT** = Antivipmyn Tri	

1. The presence of one or more of the criteria for each category in Table 1 (universal treatment) is generally sufficient to diagnose the syndrome, determine severity, and initiate treatment. Patients who present with "mixed syndromes" (signs and symptoms of > 1 syndrome present) receive the same initial doses of antivenom as those presenting with a single syndrome.

   To identify the appropriate antivenom and initial dosing for your patient, refer to the regionally specific snakebite treatment for each combatant command section later in this document. Each COCOM section includes instructions on preparation, dosing, and administration of each antivenom.

2. In certain instances, pretreatment with a low dose of SQ epinephrine prior to antivenom administration may be recommended to reduce the risk of an adverse reaction to antivenom therapy. Refer to pretreatment with epinephrine to prevent early adverse reactions for specific guidelines on pretreatment.

3. The majority of severe early reactions to antivenom occur within the first 5 - 60 minutes after antivenom administration. ***Observe and monitor the patient closely at the bedside for a minimum of one hour after each dose of antivenom has been given***.

   Refer to management of mild, moderate, and severe antivenom reactions for specific guidelines on how to manage mild, moderate, or severe reactions to antivenom therapy

ADJUNCT TREATMENTS & SUPPORTIVE CARE

SUPPORTIVE CARE & ONGOING MANAGEMENT

Provide supportive care and address secondary issues related to the envenomation as follows:

1. Anticipate the need for aggressive airway management with intubation and prolonged ventilation in all patients presenting with neurotoxic envenomation, particularly those who present late with impending respiratory failure or fail to respond to antivenom.

   - For any neurotoxic snakebite producing a cholinergic crisis, consider atropine 0.5 mg IV/IO titrated by auscultation to dry up bronchial and oral hypersecretions posing a risk to airway or breathing.

     Repeat original dose every 5 minutes until resolution of crackles, rales, bronchospasm has been achieved. Pediatric atropine doses should be weight based at a dose of 0.01 mg/kg, up to 0.25 mg.

   - For neurotoxic snakebites in the Middle East, North Africa, and Central Asia without cholinergic crisis, but causing ptosis and respiratory muscle weakness, consider administering trial dose of 0.5 mg atropine followed by 1.0 mg neostigmine IV/IO to temporarily reverse neuromuscular weakness and delay the need for intubation. Pediatric doses should be weight based at a dose of 0.01 mg/kg, up to a maximum of 0.25 mg atropine with 0.5 mg neostigmine.[54,74–77]

     Not all patients will respond, but those who do will show temporary improvement (reversal of ptosis, increased respiratory muscle strength, etc). If no response to neostigmine, do not reattempt. If positive response is achieved, repeat every 1 - 4 hours as needed (maximum dose in 24 hours = 10 mg adults / 5 mg pediatric) until antivenom has definitively reversed the paralysis.

2. For hemotoxic envenomations, all internal and external active bleeding should cease within 30 – 60 minutes of antivenom administration once the appropriate dose has been given. Packed red blood cell or whole blood transfusion can be considered if the patient is in hemorrhagic shock.[17,69,70, 78-82] Platelets, fresh frozen plasma, cryoprecipitate, TXA, and ***other agents are not effective in these cases*** due to the mechanism of the venoms.

3. Ketamine and fentanyl are preferable for analgesia. Histamine release from morphine may mask signs of an allergic reaction or worsen hypotension.
4. It is important to keep the limb significantly elevated (> 60º is ideal) whenever possible to limit dependent edema and swelling.
5. DO NOT routinely de-roof or aspirate blisters, bullae, or blebs unless they are causing significant discomfort or uncontrolled rupture appears imminent. If abscess is suspected, treat according to existing protocols for abscess management.
6. DO NOT perform fasciotomy for snakebites. Compartment syndrome is rare in snakebites. Even in cases of confirmed elevated intracompartmental pressure, patients who received antivenom without fasciotomy experienced better outcomes (shorter recovery time and less long term morbidity) than those who received fasciotomy.[83–86] Appropriate use of antivenom should resolve the underlying issue that is producing the elevated intracompartmental pressures.
7. DO NOT routinely administer antibiotics unless signs and symptoms of an infection are present. Direct infections are rare from most snakebites when prompt, appropriate treatment is given.[54]

ONGOING MONITORING & NEED FOR ADDITIONAL ANTIVENOM

1. Monitor the patient closely for signs of progression in the initial hours of treatment until control of symptoms has been achieved.

   Serial assessments for signs and symptoms of the neurotoxic, hemotoxic, and cytotoxic syndromes should be repeated at hours 2, 4, 6, 12, 24 (H2, H4, H6, H12, H24).

2. Within the first 24 hours, antivenom may be given at hours 0, 2, 4, 6, 12, and 24 according to the specific criteria for antivenom treatment listed under Criteria for Initial Antivenom Treatment and Repeat Doses.
   a. If the treatment criteria have not been resolved at any of these intervals, give an additional dose of antivenom at hours 2, 4, 6, 12, and 24 until control is achieved. Refer to specific dosage instructions for each product listed by COCOM.
   b. If symptoms reappear or persist for more than 24 hours after the first dose of antivenom was given, additional treatment intervals should be discussed with a physician expert.
   c. If 10 or more vials of a single antivenom have been given without any indications of improvement, consider changing to 2nd line antivenom if possible as species may not be covered. If any indications of improvement have been observed, continue with the antivenom you are using.
3. If the patient is asymptomatic but coagulopathy persists 24 hours after the first dose of antivenom was given, administer a dose of antivenom and repeat laboratory tests every 24 hours until resolution.
4. Continuous monitoring for effectiveness of antivenom dose must be done. Occasionally, pockets of venom can be trapped in swollen tissue compartments and escape into the bloodstream once circulation has improved. This is called recurrent envenomation and is most common within the first 24 - 48 hours after a severe bite with extensive swelling and blistering.[78,87–93]
   a. Continuous clinical monitoring includes hourly checks of vital signs, urine output, and detailed assessment for new or worsening signs of neurotoxic, hemotoxic, or cytotoxic envenomation.
   b. Serial laboratory studies including CBC, CMP, PT/PTT/INR, CK, fibrinogen levels (or WBCT if no advanced testing available) may be repeated every 2 hours while signs of envenomation persist.
   c. After signs of clinical resolution, monitoring can decrease to every 6 hours.

5. If indications of recurrent envenomation are detected more than 24 hours after the first dose of antivenom was given, treat as follows:
    a. Asymptomatic patient with coagulopathy and no other findings:
    Administer a dose of antivenom and repeat laboratory tests every 24 hours until resolution.
    b. Symptomatic patient with new or worsening pain, swelling, bleeding, neurotoxicity, or other indications of active envenomation:
    Administer an additional dose of antivenom every 2 hours until acute symptoms have resolved completely.

Discharge Recommendations

1. Patients should be held for at least 24 hours after resolution of all signs and symptoms, and the following steps should be completed prior to discharge:
    a. Repeat blood tests before releasing the patient to ensure resolution of coagulopathy.
    b. Administer a booster dose of tetanus toxoid if needed.
    c. Patients should be instructed to return if any new or worrying signs or symptoms develop.
2. Serum sickness is characterized by flu-like symptoms ± rash that typically develops between 1 - 3 weeks after antivenom administration. It is rare with highly purified modern antivenoms but may occur more frequently with some of the second and third line antivenoms listed in this CPG.[94–97]

    Serum sickness may be uncomfortable but is not dangerous. Management is either symptomatic or with a course of oral steroids.[94,95,97–99]

Criteria for Initial Antivenom Treatment & Repeat Doses

Cytotoxicity

The presence of significant local pain OR progressive edema OR signs of tissue destruction (bruising, blistering, necrosis) is an indication for initial administration of antivenom.[1,47,48,79,100–105] If any of these criteria (or other systemic signs and symptoms) are present, treat immediately and do not wait for irreversible damage to occur before deciding to give antivenom. Note that the progression of edema at any treatment interval is an indication to administer additional antivenom; however, edema may not begin to noticeably decrease for several days and severe edema may take 1 - 2 weeks or longer to completely resolve. WORSENING edema is therefore a treatment criteria, persistence of edema without any progression IS NOT a treatment criteria. Worsening pain that increases significantly in severity or moves proximally up the limb is another indicator for antivenom treatment.

Neurotoxicity

The onset, persistence, or resumption of systemic neurotoxic signs of envenomation (dyspnea, neck flexor muscle weakness, bulbar muscle weakness, reduced level of consciousness, ↓ respiratory muscle function, etc.) at any of the antivenom treatment intervals is always an indication to administer or re-administer antivenom.[1,50,107–109] Monitor respiratory function using negative inspiratory force (NIF) or forced vital capacity (FVC), single breath count test (SBC), capnography, spirometry, peak flow meters, etc.[1,54,72] In patients who have not reached the late stages of respiratory distress/arrest, the first indications that paralysis is improving may be apparent within 30 - 60 minutes once the right dose of antivenom has been achieved. In patients who are

already intubated, it may take hours for reversal to occur after antivenom. This typically occurs within 1 - 3 hours, but may take 6 - 12 hours or longer in some patients. There are numerous documented cases of patients who did not receive antivenom and required prolonged mechanical ventilation ranging from several days up to 13 weeks before recovery. Antivenom typically either reverses the syndrome before it progresses or dramatically shortens the duration of paralysis.

BLEEDING

The onset, persistence, or resumption of any active local or systemic bleeding at any of the standard assessment intervals (0, 2, 4, 6, 12, 24 hours) is always an indication to administer or re-administer antivenom regardless of the WBCT result at the time.[1,70,78,106,109–111] All external and internal bleeding will cease when the appropriate dose of antivenom has been given and actively circulating venom has been neutralized.

WBCT/COAGULATION TESTS

Tests of coagulation usually normalize within 2 - 6 hours after the effective dose of antivenom has been achieved but in some cases it may take longer for these labs to fully normalize after antivenom therapy.[78,112–120] WBCT procedure and interpretation is covered in Appendix A: Whole Blood Clotting Test (WBCT) for Venom-Induced Consumptive Coagulopathies (VICC).

There are three situations where an abnormal WBCT or other abnormal laboratory tests of coagulation (e.g. fibrinogen, PT/PTT/INR, etc) should be treated with antivenom:

1. Initial assessment at H0: Coagulopathy after a snakebite is an indication to give antivenom. If the coagulation test is abnormal but the patient is otherwise asymptomatic, repeat the test using a new glass tube to confirm the result prior to antivenom administration.[78,111,113,114,121]
2. H2, H4, H6, H12, H24: a previously normal coagulation test that changes to abnormal in the presence of any new symptoms meets criteria to administer an additional dose of antivenom. This also applies to a WBCT that was abnormal, normalized several hours after antivenom, but then changes to abnormal again later (recurrent envenomation).[78]
3. Coagulopathy remains abnormal at H24: If WBCT or other tests of coagulation remain abnormal at H24, administer an additional dose of antivenom and repeat every 24 hours until resolution of coagulopathy has occurred.

SUDDEN COLLAPSE SYNDROME

In rare cases, a patient may rapidly deteriorate in the first 5 - 30 minutes after the bite and present with profound hypotension, tachycardia, angioedema, altered level of consciousness, etc.[1,122–130] These patients should be aggressively treated for severe anaphylaxis and severe envenomation simultaneously. Treat anaphylaxis aggressively according to anaphylaxis protocols. Treat the envenomation with an initial high dose (at least 6 vials) of antivenom by rapid IV push, and support the patient with airway management, fluids, and other interventions as appropriate.[122,123,125,131,132] Most patients presenting with hypotension or angioedema are responsive to epinephrine, but may require IV epinephrine infusions to achieve this effect if they are unresponsive to IM epinephrine.[122]

How to Prevent Early Adverse Reactions to Antivenom

Epinephrine is the only prophylactic treatment (pretreatment) that has been shown to effectively reduce the incidence of early adverse reactions (EARs) such as anaphylaxis.[60,98,133–136]

1. ***DO NOT pretreat with steroids or antihistamines.***
2. ***DO NOT administer test doses of antivenom to check for hypersensitivity.***[60–63]

Relative contraindications to epinephrine pretreatment include age > 70, hypertension, ischemic heart disease, history of stroke, suspected or confirmed intracranial hemorrhage. No absolute contraindications.

1. Pretreatment with epinephrine prior to antivenom administration is not indicated by default for all antivenoms, and is recommended only under the following circumstances:
    a. Unstable snakebite patients with signs of shock.
    b. Known history of atopy (asthma, eczema, etc.), equine hypersensitivity, or severe reactions to antivenom in the past.
    c. Use of certain second or third line antivenom due to the high rate of serious EARs associated with these products.
2. Standard epinephrine pretreatment protocol:
    a. Adult dose is 0.25 mg of 1:1000 epinephrine given by SQ injection several minutes prior to antivenom administration.
    b. Pediatric doses should be weight based at a dose of 0.01 mg/kg, up to 0.25 mg.[60,134,135,137,138]
    c. Patients with signs of shock should be given epinephrine by IM injection in the lateral thigh

How to Manage Mild, Moderate & Severe Antivenom Reactions

Mild or Moderate Reaction during Infusion

1. Stop the infusion and manage mild or moderate reactions (e.g. nausea, vomiting, urticaria, pruritus, chills, fever, etc.) symptomatically as needed with antiemetics, antihistamines, steroids, etc.
2. Reassess the patient once the reaction has been controlled; if the antivenom treatment criteria for cytotoxic, hemotoxic, or neurotoxic syndromes have not resolved completely then resume the infusion at a slower rate over 30 minutes.
3. If giving via push, dilute the remaining dose of antivenom in a 100 - 500 mL bag of normal saline and give as 30-minute infusion.

Severe Reaction (Anaphylaxis) during Infusion

1. Stop the infusion and treat according to the anaphylaxis treatment protocol.
   Reassess the patient once the reaction has been controlled; if the antivenom treatment criteria for cytotoxic, hemotoxic, or neurotoxic syndromes have not resolved completely then resume the infusion at a slower rate over 30 minutes.

2. If giving via push, dilute the remaining dose of antivenom in a 100-250 mL bag of normal saline and give as 30-minute infusion.
3. If the reaction occurs, stop the infusion, and consult a physician expert via telemedicine to discuss next steps for management.

Anaphylaxis Treatment Protocol

NOTE: Intubate for airway edema not rapidly responsive to epinephrine.

If anaphylaxis occurs after antivenom administration, treat according to the following protocol:

1. First line treatment of anaphylaxis is rapid administration of 1:1000 epinephrine (initial adult dose = 0.5 mg IM in the lateral thigh for rapid absorption). Epinephrine can be repeated as needed until the patient has stabilized and/or an intravenous or intraosseous infusion administered as per standard protocols if the patient fails to respond to IM doses.
   Epinephrine should always be given prior to antihistamines or steroids to counter the immediate life-threats of bronchospasm and vasodilation.
2. After epinephrine has been given:
   a. Give methylprednisolone 125 mg IV
   b. Give diphenhydramine 50 mg IV.
   c. Consider adding an H2 antihistamine such as ranitidine.

If anaphylaxis occurs during administration of antivenom, stop the antivenom administration to treat the reaction, then resume the antivenom administration as described below. [15,61,95,99,128,129,140–146]

Late Reactions to Antivenom (Serum Sickness)

1. Serum sickness is characterized by flu-like symptoms ± rash that typically develops between 1 - 3 weeks after antivenom administration. Serum sickness may be uncomfortable, but it is not dangerous.
2. Serum sickness may be uncomfortable, but it is not dangerous.
3. Management is either symptomatic with antihistamines, acetaminophen, or with a course of oral steroids for patients who are in significant discomfort.[94,95,97–99]

Special Situations

If Antivenom is Unavailable

1. Antivenom is the gold standard of care for symptomatic snake envenomations. Early treatment is the best strategy to prevent death, amputation, or other serious disability. Management of snake envenomations when antivenom is not available should be directed at getting the patient to the antivenom (or vice versa) as quickly as possible to prevent irreversible damage to organs and tissues.
2. Mission planning before deployment should include research and procurement of the appropriate regionally specific antivenom(s) recommended in this CPG for your area of operation. If currently deployed without antivenom, efforts to acquire the appropriate antivenom(s) recommended in this CPG for your area of operations should be initiated through proper channels as fake or low-quality antivenoms are frequently found in local pharmacies throughout Africa and elsewhere in the developing world.

3. For specific management until antivenom can be obtained, follow the checklist and skip the steps related to antivenom administration until it has been obtained.

   Refer to Supportive Care measures for specific recommendations.

Military Working Dogs/Multipurpose Canines

All antivenoms can be administered to military working dogs (MWD) and multipurpose canines according to the treatment criteria and initial doses listed in this CPG; other management should be based on the MWD CPG.

Late Presentations and Treatment Delays

There is no defined time limit to antivenom therapy for a symptomatic snakebite. Early antivenom within the first minutes or hours after a bite is the best means of preventing morbidity or mortality, but antivenom remains effective at resolving reversible issues like coagulopathy and preventing further irreversible tissue damage even in patients who present many hours or days after the snakebite.[56,69,78,146,147]

Outdated Interventions That Should Not Be Performed

1. DO NOT cut, suck, electrocute, burn, or use chemicals on the envenomation site.
2. **DO NOT apply constricting bandages, tourniquets, or other circulation-reducing intervention!**
3. DO NOT use venom extractors or other commercial snakebite first aid kits. [148–152]
4. DO NOT administer test doses of antivenom to check for hypersensitivity as these are ineffective and waste both time and antivenom.[60–63]
5. DO NOT administer antihistamines or steroids as prophylactic pretreatment for prevention of anaphylaxis or other early adverse reactions (EARs) to antivenom as neither is effective as a premedication.[133,134]

OCULAR ENVENOMATION BY SPITTING COBRAS (VENOM OPTHALMIA)

Spitting cobras have modified fangs that allow them to spray venom into the eyes of a predator or perceived threat.[153–155] The venom spray widens like buckshot as it travels and the snakes aim at the glint of sunlight reflecting off of the target's eyes. The venom is harmless unless it enters the eyes (causing instantaneous burning, lacrimation, blurred vision, etc.) or the bloodstream by injection (such as a bite), through open wounds on the skin or inside of the mouth, or by ingestion (such as drinking a glass of venom with an ulcer). If a significant amount of venom enters the bloodstream through an open wound and produces typical symptoms of a snakebite, it is treated with antivenom like any other envenomation. For ocular exposure alone without signs of systemic envenomation, antivenom is not indicated and the management is like any ocular chemical exposure with copious irrigation. Spitting cobras can also deliver a venomous bite, so it is important to rule out an actual snakebite in patients who have encountered one of these snakes.

Signs and Symptoms

Immediate signs and symptoms of venom ophthalmia include intense local pain, swelling and/or spasms of the eyelid, lacrimation, and leukorrhea.[156] The primary concern is corneal epithelial injury which can lead to blindness by secondary infection or scarring if not treated correctly.[7,25,54,156–158] Treatment of venom ophthalmia is relatively simple and similar to managing a patient who has been splashed in the eyes with a harmful chemical solution.

First Aid

Confirm that the patient did not experience a snakebite in addition to the ophthalmia. Immediately irrigate the eye with copious quantities of water, normal saline, or a bland fluid such as milk if nothing else is available. Remove clothing and decontaminate the patient from head to toe with soap and water to prevent second re-exposure to dried venom.[54]

Clinical Management

Apply topical anesthetic eye drops (tetracaine) to facilitate thorough irrigation and examination of the affected eyes. Irrigate the eyes thoroughly using water or normal saline for ≥ 15 minutes.[156]

Fluorescein stain and examination using a slit lamp or ophthalmoscope for corneal injury. If present, treat with antimicrobial eye drops (such as tetracycline and chloramphenicol) or ointments and mydriatics. Reassess daily with slit lamp examination. If absent, consider benefits vs risks of antimicrobial eye drops.

Additional Treatments to Consider

Topical eye drops containing either epinephrine (1:1000) or phenylephrine (10%) are reported to immediately relieve the burning sensation produced by the venom.[54,156]

Contraindicated Treatments

Antivenom (topical or systemic) is not indicated for patients with ocular exposure to snake venom.[54,156,159] Topical steroids are contraindicated for these patients.

REGIONALLY SPECIFIC SNAKEBITE TREATMENT

There are a number of different antivenoms included in this CPG for snakebite treatment in AFRICOM, CENTCOM, INDOPACOM, EUCOM, NORTHCOM, and SOUTHCOM. The coverage, initial dosing, preparation, and administration vary between products and details for each of them are included. Simplified algorithms for selecting and dosing each antivenom are also included in each regional section below.

Whenever possible, broad-spectrum, field-stable antivenoms are recommended to enable syndromic diagnosis and treatment at the point of injury without the need to identify the species responsible for the bite. Citations of the relevant literature on safety, efficacy, and dosing for each product are provided in the references section.

Determine the appropriate first line antivenom for your area of operations prior to deployment using this section, then refer back to the Universal Approach to Snakebite Assessment, Diagnosis, and Treatment earlier in the document for detailed instructions and a stepwise approach to snakebite management throughout the course of care. Abbreviated antivenom guidelines for each regional combatant command are included below.

Categorization of Medically Significant Snake Species

The World Health Organization (WHO) classifies the risk posed by various venomous snakes by designating each species as either Category 1 or Category 2 as described below. WHO guidelines state that the “species listed in Category 1 within a country, territory or area should be considered as being of highest priority for antivenom production on the basis that available knowledge implicates them as being responsible for the greater burden in that particular setting.” [160]

WHO Category 1: Venomous Snakes of Highest Medical Importance

Defined as "highly venomous snakes which are common or widespread and cause numerous snakebites, resulting in high levels of morbidity, disability or mortality."

WHO Category 2: Venomous Snakes of Secondary Medical Importance

Defined as "highly venomous snakes capable of causing morbidity, disability or death, for which exact epidemiological or clinical data may be lacking; and/or which are less frequently implicated (due to their activity cycles, behavior, habitat preferences or occurrence in areas remote to large human populations)."

NOTE: Antivenom Infusion versus Direct Push:
For most first line antivenoms in this CPG, administration using either a) 100, 250, or 500 mL IV bag of isotonic fluids with 10-minute IV/IO infusion or b) direct IV push is recommended in order to get a full dose of antivenom onboard as quickly as possible and neutralize venom before further damage has occurred. However, if this is not possible it is acceptable to dilute antivenom in any size bag of isotonic solution you have available and give over 10 – 30 minutes.

CONTACT

For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

AFRICOM

TREATMENT GUIDELINES

Safe and effective broad-spectrum, field-stable antivenoms are available for all three syndromes of snake envenomation in this AOR and treatment does not require identification of the species responsible. Snakebite treatment at the point of injury is recommended for AFRICOM due to prolonged evacuation times, high incidence of snakebites, and the high risk of death or permanent disability from many venomous snakes in the AOR if early antivenom treatment is not available.

ADVERSE REACTION MANAGEMENT

- If a mild or moderate reaction occurs, slow the infusion and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed. Refer to management of adverse reactions for specific instructions.
- If a severe reaction such as anaphylaxis occurs, stop the infusion and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

1. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols.
2. Intubate for airway edema not rapidly responsive to epinephrine.
3. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation.
4. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom takes effect to reverse hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

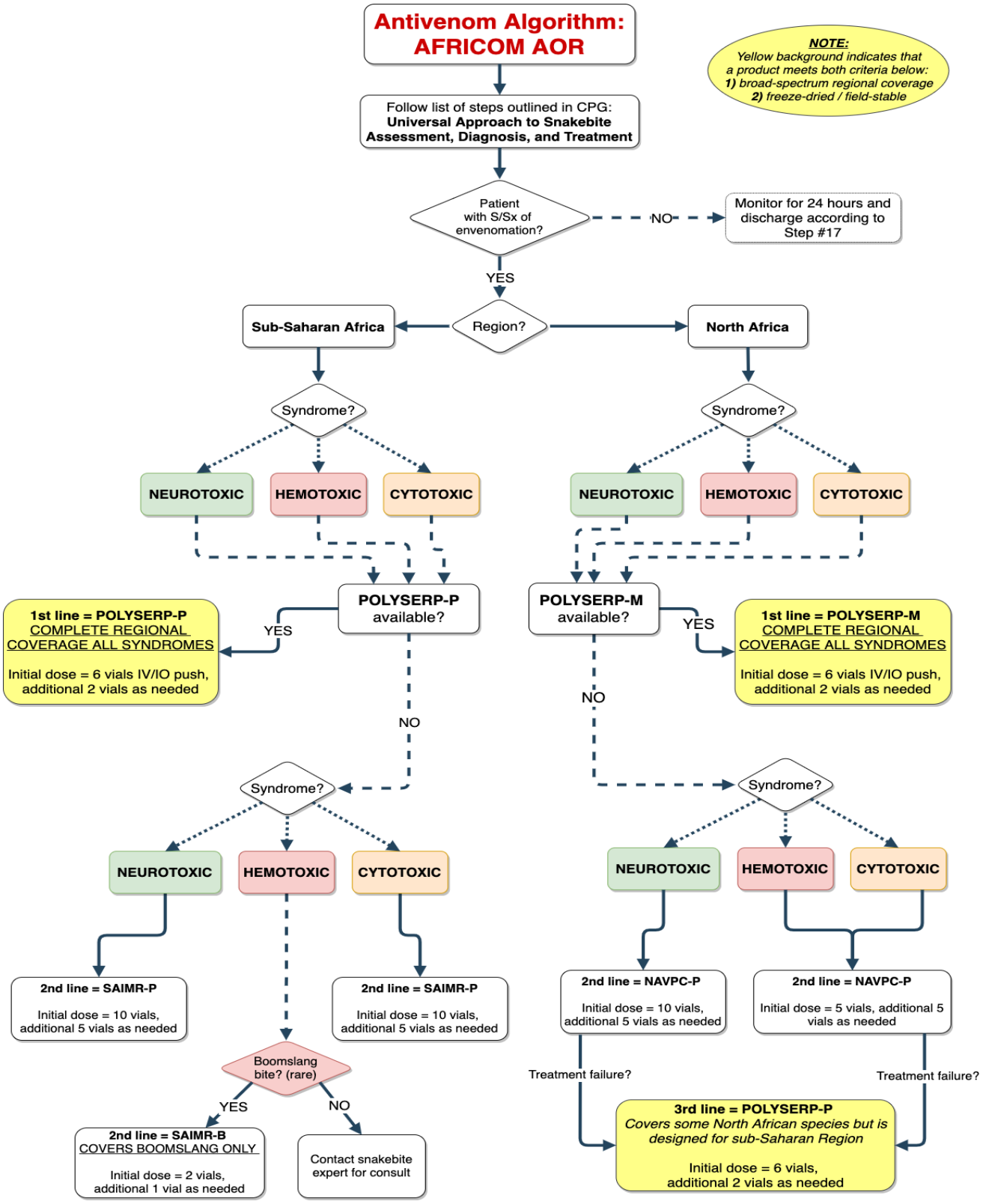
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 3. AFRICOM: First Line Antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc.); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	Additional doses if: persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until signs of improvement begin to appear (↑SBC, ↑LOC, ↑strength, etc.)	Additional doses if: persistence, resumption, or new onset of any active external or internal bleeding **OR** S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT	Additional doses if: significant increase in edema (such as beyond major joint) **OR** significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)
AFRICOM 1st Line Antivenoms	Sub-Saharan Africa: Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known or unknown species - POLYSERP-P: Initial dose = 6 vials / Additional doses = 2 vials as needed North Africa: Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known or unknown species - POLYSERP-M: Initial dose = 6 vials / Additional doses = 2 vials as needed		
Antivenom Abbreviations	**POLYSERP-P** = POLYSERP PAN-AFRICA **POLYSERP-M** = POLYSERP MENA		

Figure 2. Antivenom Algorithm: AFRICOM AOR


Antivenom Algorithm: AFRICOM AOR
NOTE: Yellow background indicates that a product meets both criteria below: 1) broad-spectrum regional coverage 2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
YES
Region?
Sub-Saharan Africa
North Africa
Syndrome?
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
POLYSERP-P available?
YES
1st line = POLYSERP-P COMPLETE REGIONAL COVERAGE ALL SYNDROMES
Initial dose = 6 vials IV/IO push, additional 2 vials as needed
NO
POLYSERP-M available?
YES
1st line = POLYSERP-M COMPLETE REGIONAL COVERAGE ALL SYNDROMES
Initial dose = 6 vials IV/IO push, additional 2 vials as needed
NO
Syndrome?
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
2nd line = SAIMR-P
Initial dose = 10 vials, additional 5 vials as needed
2nd line = SAIMR-P
Initial dose = 10 vials, additional 5 vials as needed
2nd line = NAVPC-P
Initial dose = 10 vials, additional 5 vials as needed
2nd line = NAVPC-P
Initial dose = 5 vials, additional 5 vials as needed
Boomslang bite? (rare)
YES
NO
Treatment failure?
Treatment failure?
2nd line = SAIMR-B COVERS BOOMSLANG ONLY
Initial dose = 2 vials, additional 1 vial as needed
Contact snakebite expert for consult
3rd line = POLYSERP-P
Covers some North African species but is designed for sub-Saharan Region
Initial dose = 6 vials, additional 2 vials as needed

FIRST LINE (AFRICOM - SUB-SAHARAN): POLYSERP-P

POLYSERP/Inosan, Spain - POLYSERP PAN-AFRICA Polyvalent (POLYSERP-P)
(Freeze dried/Unrefrigerated) [1,106,161–164]:

1. Field-stable. Broad-spectrum coverage for 24+ species Cyto/Hemo/Neuro.
2. Single-source treatment option for all neurotoxic, hemotoxic, and cytotoxic snake envenomations in sub-Saharan Africa when the causative species is either unknown or among the 24 snakes for which this product is directly indicated. Only polyvalent to include boomslangs and only antivenom for mole viper envenomations. Directly or indirectly covers all of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.
3. Initial dose = 6 vials all syndromes, additional doses = 2 vials as needed.

THIRD LINE (AFRICOM - NORTH AFRICA): POLYSERP-P

POLYSERP/Inosan, Spain - POLYSERP PAN-AFRICA Polyvalent (POLYSERP-P)
(Freeze dried/Unrefrigerated) [1,106,161–164]:

Indicated for all neurotoxic, hemotoxic, or cytotoxic envenomations in North Africa with no signs of improvement after 10 vials of POLYSERP-M and/or NAVPC-P. Directly or indirectly covers some of the WHO category 1 and category 2 snakes in North Africa.

Feasibility of use in austere environments: Recommended for use in operational settings and specifically designed to fill the capability gap for ground medics operating in these areas. Updated version of Inoserp Pan-Africa made specifically for the austere and operational medicine environment. Freeze-dried, unrefrigerated, stable at temperatures >100º F for at least 180 days without loss of efficacy. Broad coverage and simple dosing enable administration in the field for any symptomatic snakebite by unknown species in this region. Special operations and conventional units deploying to austere operational environments and areas with critical threat venomous species should carry 8 vials per medic. It is recommended that a reserve quantity is stocked in all role 2 and role 3 facilities in AFRICOM in case additional antivenom is needed upon arrival, and also to restock field medics that have used their supply.

Adverse reactions: High efficacy against all major syndromes and very low 0.2% incidence of serious adverse reactions based on current publications.

Indications: Broad spectrum polyvalent directly indicated for the treatment of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes caused by 24 different species of African snakes from the families Elapidae, Viperidae, Colubridae, and Atractaspididae.

- NEUROTOXIC: *Dendroaspis angusticeps, D. jamesoni, D. polylepis, D. viridis; Naja anchieta, N. annulifera, N. haje, N. senegalensis; Naja melanoleuca*
- CYTOTOXIC and/or HEMOTOXIC: *Atractaspis irregularis; Bitis arietans, B. gabonica, B. nasicornis, B. rhinoceros; Cerastes cerastes; Dispholidus typus; Echis leucogaster, E. ocellatus, E. pyramidum; Naja katiensis, N. mossambica, N. nigricollis, N. nubiae, N. pallida*

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 6 vials
- HEMOTOXIC initial dose = 6 vials

- CYTOTOXIC initial dose = 6 vials

Additional dosing: Additional doses of 2 vials POLYSERP-P may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Reconstitute every 2 vials of POLYSERP-P in the same 10 mL syringe by mixing the first vial, drawing it back up into syringe, and injecting it into the second vial to yield 2 vials/1 syringe (6 vial dose = 3 syringes total). Administer sequentially via slow, continuous direct IV or IO push over approximately 2 minutes each. If a reaction occurs stop the push, treat the reaction, reassess response to treatment criteria. Dilute remaining dose in a 100 mL bag of isotonic fluids and administer via slow IV or IO infusion over 30 mins if needed.

Direct push is recommended for convenience, but POLYSERP-P may also be administered via IV or IO infusion. Mix in a 50 mL or 100 mL bag of isotonic fluids and administer the entire bag over 5 – 10 mins.

FIRST LINE (AFRICOM - NORTH AFRICA): POLYSERP-M

POLYSERP/Inosan, Spain - POLYSERP MENA Polyvalent (POLYSERP-M) (Freeze dried/unrefrigerated) [156–172]:

1. Field-stable. Broad-spectrum coverage for 27+ species Cyto/Hemo/Neuro.
2. Single-source treatment option for all neurotoxic, hemotoxic, and cytotoxic snake envenomations in North Africa (Algeria, Egypt, Libya, Morocco, Tunisia, Western Sahara) when the causative species is either unknown or among the 27 snakes for which this product is directly indicated. Directly or indirectly covers all of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.
3. Initial dose = 6 vials all syndromes, additional doses = 2 vials as needed.

Feasibility of use in austere environments: Recommended for use in operational settings and specifically designed to fill the capability gap for ground medics operating in these areas. Updated version of Inoserp MENA made specifically for the austere and operational medicine environment. Freeze-dried, unrefrigerated, stable at temperatures >100º F for at least 180 days without loss of efficacy. Broad coverage and simple dosing enable administration in the field for any symptomatic snakebite by unknown species in this region. Special operations and conventional units deploying to austere operational environments and areas with critical threat venomous species should carry 8 vials per medic. It is recommended that a reserve quantity is stocked in all role 2 and role 3 facilities in AFRICOM in case additional antivenom is needed upon arrival, and also to restock field medics that have used their supply.

Adverse reactions: High efficacy against all major syndromes and low incidence of serious adverse reactions of approximately 1% based on current publications.

Indications: Broad spectrum polyvalent directly indicated for the treatment of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes caused by 27 different species of Middle Eastern, North African, and Central Asian snakes from the families *Elapidae* and *Viperidae*. First line for snake envenomations in this region when the causative species is unknown or among those for which the product is directly indicated.

- **NEUROTOXIC**: Naja haje, N. oxiana; Walterinnesia aegyptia
- **CYTOTOXIC** and/or **HEMOTOXIC**: *Bitis arietans; Cerastes cerastes, C. vipera, C. gasperettii; Daboia palestinae, D. mauritanica, D. deserti; Echis. carinatus sochureki, E. coloratus, E. khosatskii, E. leucogaster, E. megalocephalus, E. omanensis, E. pyramidum; Macrovipera lebetina obtusa, M. l. transmediterranea, M. l. turanica; Montivipera bornmuelleri, M. raddei kurdistanica; Naja nubiae, N. pallida; Pseudocerastes persicus persicus, P. fieldi; Vipera latastei*

Pretreatment: ***Not routinely indicated*** unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 6 vials
- HEMOTOXIC initial dose = 6 vials
- CYTOTOXIC initial dose = 6 vials

Additional dosing: Additional doses of 2 vials POLYSERP-M may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Reconstitute every 2 vials of POLYSERP-M in the same 10 mL syringe by mixing the first vial, drawing it back up into syringe, and injecting it into the second vial to yield 2 vials/1 syringe (6 vial dose = 3 syringes total). Administer sequentially via slow, continuous direct IV or IO push over approximately 2 minutes each. If a reaction occurs stop the push, treat the reaction, reassess response to treatment criteria. Dilute remaining dose in a 100 mL bag of isotonic fluids and administer via slow IV or IO infusion over 30 mins if needed.

Direct push is recommended for convenience, but POLYSERP-M may also be administered via IV or IO infusion. Mix in a 50 mL or 100 mL bag of isotonic fluids and administer the entire bag over 5 – 10 mins.

SECOND LINE (AFRICOM - SUB-SAHARAN AFRICA): SAIMR-P

South African Vaccine Producers, South Africa - SAVP SAIMR Polyvalent Snake Antivenom (SAIMR-P) (Liquid/refrigerated) [50,173–181] :

1. Not field stable. Broad-spectrum against 10+ species neurotoxic and cytotoxic only.
2. Unknown neurotoxic and/or cytotoxic envenomation in sub-Saharan Africa or with no indications of improvement after 10 vials of POLYSERP-P. Will not treat hemotoxic envenomations. Southern Africa: Directly or indirectly covers all WHO category 1 and category 2 species for which an antivenom currently exists. East/Central/West Africa: Covers many cytotoxic and neurotoxic snakes in West, Central, and East Africa but has major coverage gaps with no efficacy against all WHO category 1 or category 2 hemotoxic snake species.
3. Initial dose = 10 vials neurotoxic/cytotoxic only, additional doses = 5 vials

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration. Recommend storing small quantities at strategically located Role 2 & 3 facilities in AFRICOM AOR.

Adverse reactions: High efficacy but very high rates of anaphylaxis ranging from 25% - 75% have been documented in multiple publications.

Indications: This polyvalent can be used to treat neurotoxic and cytotoxic envenomations by 10 different species of African snakes. The product has been used successfully to treat additional species of African snakes through paraspecific neutralization, but research in this area is limited and most experiences are anecdotal. The 10 species listed below are the official treatment indications recommended by the manufacturer:

- NEUROTOXIC SNAKES: *Dendroaspis polylepis, D. angusticeps, D. jamesoni, Naja melanoleuca, N. nivea, N. annulifera*
- CYTOTOXIC SNAKES: *Bitis arietans, B. gabonica, Naja mossambica, Hemachatus haemachatus*

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 10 vials
- Not indicated for hemotoxic

- CYTOTOXIC initial dose = 10 vials

Additional dosing: Additional doses of 5 vials SAIMR-P may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Recommended for this antivenom. Administer 0.25 mg epinephrine injected SQ prior to beginning antivenom infusion to reduce the risk of a serious reaction. Pediatric epinephrine dose is weight based (0.01 mg/kg).

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

SECOND LINE, Boomslang (AFRICOM - SUB-SAHARAN AFRICA): SAIMR-B

South African Vaccine Producers, South Africa - SAVP SAIMR Boomslang Monovalent (SAIMR-B) (Liquid/Refrigerated) [173–181]:

1. Not field stable. Not broad-spectrum. Single species coverage.
2. Confirmed or suspected boomslang bite with no indications of improvement after 10 vials of POLYSERP-P. Monovalent that can only be used to treat the WHO category 2 boomslang. Does not provide coverage against any other WHO category 1 or category 2 species.
3. Initial dose = 2 vials boomslang only, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities in sub-Saharan Africa.

Adverse reactions: No clinical trials but effective anecdotally and in case reports. Moderate to high rates of anaphylaxis are anticipated based on limited case reports of patients treated with SAIMR-B.

Indications: This monovalent is only effective for the boomslang.

- Hemotoxic: *Dispholidus typus*

Initial dosing by syndrome:

- Not indicated for neurotoxic
- Hemotoxic with confirmed or suspected boomslang bite (typical onset coagulopathy and bleeding 1 – 3 days after the bite; no significant pain, swelling, or tissue destruction)
  - Initial dose = 2 vials SAIMR-B
  - POLYSERP-P should be the first line treatment for this species if available due to lower risk of allergic reactions.
- Not indicated for hemotoxic envenomation by snakes other than the boomslang
- Not indicated for cytotoxic

Additional dosing: Additional doses of 1 vial SAIMR-B may be repeated, if needed, at hours 2, 4, 6, 12, and 24 until cessation of all active bleeding or at 6, 12, and 24 for coagulopathy without bleeding.

Pretreatment: RECOMMENDED for this antivenom. Administer 0.25 mg epinephrine injected SQ prior to beginning antivenom infusion to reduce the risk of a serious reaction. Pediatric doses should be weight based at a dose of 0.01 mg/kg, up to 0.25 mg.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

SECOND LINE (AFRICOM - NORTH AFRICA): NAVPC-C

National Antivenom & Vaccine Production Center, Saudi Arabia - Polyvalent Snake Antivenom (NAVPC-P) (Liquid/Refrigerated)[182-186]:

Unknown neurotoxic, hemotoxic, or cytotoxic envenomation with no indications of improvement after 10 vials of POLYSERP-M. Directly or indirectly covers some of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.

1. Not field stable. Broad-spectrum coverage 6+ species of Neuro/Hemo/Cyto.
2. Unknown neurotoxic, hemotoxic, or cytotoxic envenomation with no indications of improvement after 10 vials of POLYSERP-M. Directly or indirectly covers some of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.
3. Initial dose neuro = 10 vials. Initial dose hemo/cyto = 5 vials. All additional doses = 5 vials.

Feasibility of use in austere environments: NOT RECOMMENDED for operational settings. Requires refrigeration, moderate to high rates of adverse reactions are anticipated. Better alternatives exist. If purchased, it should be kept at Role 2 & 3 facilities in the Arabian Peninsula.

Adverse reactions: Insufficient evidence to determine risk of adverse reactions at this time.

Indications: This polyvalent can be used to treat neurotoxic and cytotoxic envenomations by 6 different species of Middle Eastern, North African, and Central Asian snakes. It may be able to neutralize venom from additional species through paraspecific neutralization but this has not been researched.[187–192] The six species listed below are the official treatment indications recommended by the manufacturer:

- NEUROTOXIC: *Walterinnesia aegyptia, Naja haje*
- HEMOTOXIC and/or CYTOTOXIC: *Bitis arietans, Echis coloratus, Echis carinatus, Cerastes cerastes*

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 10 vials
- HEMOTOXIC initial dose = 5 vials
- CYTOTOXIC initial dose = 5 vials

Additional dosing: Additional doses of 5 vials NAVPC-C may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Recommended for this antivenom due to insufficient evidence for determining risk of EARs. Administer 0.25 mg epinephrine injected SQ prior to beginning antivenom infusion to reduce the risk of a serious reaction. Pediatric doses should be weight based at a dose of 0.01 mg/kg, up to 0.25 mg.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

AFRICOM ANTIVENOM FORMULATION COMPARISON

Formulation, storage, stability, safety, and efficacy for six antivenoms available in the AFRICOM area of responsibility. EchiTAb-Plus is included for reference but is not recommended due to limited species coverage, low availability, and high rates of anaphylaxis.
Note: Specific indications according to the package insert.

Table 4a. AFRICOM Antivenom Formulation Comparison

PRODUCT PROFILE	**[NAVPC-P]** NORTH AFRICA	**[POLYSERP-M]** NORTH AFRICA	**[POLYSERP-P]** SUB-SAHARAN	**[SAIMR-P]** SUB-SAHARAN	**[SAIMR-B]** SUB-SAHARAN	**[EchiTAb-Plus]** SUB-SAHARAN
Type of Immunoglobulin	$F(ab')_2$ fragment; Equine	$F(ab')_2$ fragment; Equine	$F(ab')_2$ fragment; Equine	$F(ab')_2$ fragment; Equine	$F(ab')_2$ fragment; Equine	Intact IgG; Equine
Coverage	6 species polyvalent	27 species polyvalent	24 species polyvalent	10 species polyvalent	1 species monovalent	3 species polyvalent
Elapids	• **Desert black snake: 1 species** (*Walterinnesia aegyptia*) • **Neurotoxic cobras: 1 species** *(Naja haje)*	• **Desert black snake: 1 species** (*Walterinnesia aegyptia*) • **Spitting cobras: 2 species** (*Naja nubiae, N. pallida*) • **Neurotoxic cobras: 2 species** *(Naja haje, N. oxiana)*	• **Mambas: 4 species** (*Dendroaspis polylepis, D. viridis, D. angusticeps, D. jamesoni*); • **Spitting cobras: 5 species** (*Naja nigricollis, N. pallida, N. nubiae, N. katiensis, Naja mossambica*) • **Neurotoxic cobras: 5 species** *(Naja haje, N. senegalensis, N. anchieta, N. annulifera*, *N. melanoleuca*)	• **Mambas: 3 species** (*Dendroaspis polylepis, D. angusticeps, D. jamesoni*); • **Spitting cobras: 2 species** (*Naja mossambica, Hemachatus haemachatus*); • **Neurotoxic cobras: 3 species** (*Naja melanoleuca, N. nivea, N. annulifera*)	----------	• **Spitting cobras: 1 species** *(Naja nigricollis)*
Viperids	• **Saw-scaled vipers: 2 species** (*Echis coloratus, E. carinatus*) • **Large African adders: 1 species** (*Bitis arietans)* • **Desert horned vipers: 1 species** *(Cerastes cerastes)*	• **Saw-scaled vipers: 7 species** (*Echis leucogaster, E. pyramidum, E. coloratus, E. khosatskii, E. megalocephalus, E. omanensis, E. carinatus sochureki*) • **Large African adders: 1 species** (*Bitis arietans)* • **Desert horned vipers: 3 species** *(Cerastes cerastes, C. vipera, C. gasperettii)* • **Old world vipers: 2 species** (*Daboia palestinae, D. mauritanica*)	• **Saw-scaled vipers: 3 species** (*Echis ocellatus, E. leucogaster, E. pyramidum*); • **Large African adders: 4 species** (*Bitis arietans, B. rhinoceros, B. nasicornis, B. gabonica*) • **Desert horned vipers: 1 species** *(Cerastes cerastes)*	• **Large African adders: 2 species** (*Bitis arietans, B. gabonica*)	----------	• **Saw-scaled vipers: 1 species** (*Echis ocellatus)* • **Large African adders: 2 species** (*Bitis arietans*)

		• **Large palearctic vipers: 4 species** *(Macrovipera deserti, M. lebetina obtusa, M. l. transmediterranea, M. l. turanica)* • **False horned vipers: 2 species** (*Pseudocerastes persicus, P. fieldi*) • **Eurasian vipers: 3 species** *(Vipera bornmuelleri, V. latastei, V. raddei kurdistanica)*				
Colubrids & Atractaspids	----------	----------	• **Burrowing asps: 1 species** *Atractaspis irregularis* • **Boomslang (1 species exists)** *Dispholidus typus*	----------	•**Boomslang** (*Dispholidus typus)*	----------

Table 4b. Antivenom Formulation Comparison

PRODUCT PROFILE	**[NAVPC-P]** NORTH AFRICA	**[POLYSERP-M]** NORTH AFRICA	**[POLYSERP-P]** SUB-SAHARAN	**[SAIMR-P]** SUB-SAHARAN	**[SAIMR-B]** SUB-SAHARAN	**[EchiTAb-Plus]** SUB-SAHARAN
Protein (mg/ml)	Unknown	≤ 100 mg/mL	≤ 100 mg/mL	111.7 ± 27.2	Unknown	40 ± ?
Preservatives	Unknown, likely cresol	None	None	≤0.35% cresol w/v	≤0.35% cresol w/v	Phenol (w/v?)
Formulation	Liquid; 10 ml vial	Lyophilized; 10 ml vial	Lyophilized; 10 ml vial	Liquid; 10 ml vial	Liquid; 10 ml vial	Liquid; 10 ml vial
Reconstitution	Liquid formulation	Less than 20 seconds	Less than 20 seconds	Liquid formulation	Liquid formulation	Liquid formulation
Cold chain required?	Yes, must be refrigerated	No, store unrefrigerated. Can be carried in pack.	No, store unrefrigerated. Can be carried in pack.	Yes, must be refrigerated	Yes, must be refrigerated	Yes, must be refrigerated
Maximum temp allowed?	"Store between 2 – 8 ºC (35.6 – 46.4 ºF)"	"Excursions permitted to 40 ºC (104 ºF) for up to 6 months"	"Excursions permitted to 40 ºC (104 ºF) for up to 6 months"	"Store between 2 – 8 ºC (35.6 – 46.4 ºF)"	"Store between 2 – 8 ºC (35.6 – 46.4 ºF)"	"Store between 2 – 8 ºC (35.6 – 46.4 ºF)"
N of published cases	**n = 252** cases in retrospective studies that examined safety and efficacy; quality limited.	**n = 315** cases reported in prospective observational studies evaluating safety and efficacy under austere conditions.	**n = 426** cases reported in prospective observational studies evaluating safety and efficacy under austere conditions.	**n = 144** cases in retrospective / prospective studies (anecdotal and observational) that reported safety and efficacy data.	**n = 5** case reports but that included safety and efficacy data but no studies to date.	**n = 206 cases in RCT**

Efficacy in clinical studies	- Appears effective against most snakebites in North Africa / Arabian Peninsula; coverage is poor outside of this area due to differences in local species. May be less effective for DIC. - The **combined CFR all was 3.57%** (9/252); deaths were a mix of ICH, DIC, cardiac arrest, respiratory arrest. Most fatalities presented early.	- Effectively treated cytotoxic, hemotoxic, neurotoxic syndromes of SBE at hospitals throughout Morocco since the country switched to using it in 2015. - The **combined CFR all was 3.17%** (10/316); mostly of organ failure, hemorrhagic shock, sepsis after long treatment delays before presentation to the hospital.	- Effectively treated cytotoxic, hemotoxic, neurotoxic syndromes of SBE at poorly equipped rural health centers in Mali, Senegal, Benin, and Guinea. - The **combined CFR all was 1.6%** (7/426); mostly hemorrhagic shock from carpet viper bites in patients with long treatment delays before presentation to the hospital.	- Effectively treated cytotoxic, hemotoxic, neurotoxic syndromes of SBE at health centers in South Africa (5 studies) and Tanzania (1 study). - The **combined CFR was 3% (**5/144); two were neurotoxic envenomations and 3 were pediatric cases with unspecified syndromes.	- No clinical studies but very effective for resolving hemotoxic effects from boomslang envenomations in case reports.	- 3 vial dose effectively treated hemotoxic syndrome of SBE due to *Echis ocellatus* in Nigeria. Hemotoxic saw-scaled viper bites only; no evidence of efficacy for other snakes / syndromes. - There were no fatalities reported; however, patients with severe envenomations, late-presenting patients, and those complex cases were excluded from the study.
Safety *(incidence of anaphylaxis)*	Very limited data and all studies acknowledge likely underreporting of reactions. Most reliable study showed **moderate incidence of anaphylaxis 5.5% (2/36);** small sample.	**Very low incidence of anaphylaxis (1%; 3/290)** in 290 cases reported and evaluated by the poison center of Morocco. No cases of serum sickness.	**Very low incidence of anaphylaxis (0.2%; 1/426))** in prospective clinical studies. Only one case of possible anaphylaxis that is more consistent with shock from the snakebite. No cases of serum sickness.	**Very high incidence of anaphylaxis (average 26%; rate is as high as 76% in some studies).** Serum sickness not reported. Underreporting likely.	**Very high incidence of anaphylaxis (60%)** in the only study that evaluated at adverse reactions to SAIMR-B. One case of serum sickness.	**High incidence anaphylaxis (10.8%, n = 21/194)** and 5 cases of serum sickness reported.

CENTCOM

Treatment Guidelines

Safe and effective broad-spectrum, field-stable antivenoms are available for all three syndromes of snake envenomation in this AOR and treatment does not require identification of the species responsible. Snakebite treatment at the point of injury is recommended for CENTCOM due to potential for prolonged evacuation times, high incidence of snakebites, and the high risk of death or permanent disability from many venomous snakes in the AOR if early antivenom treatment is not available.

Adverse Reaction Management

- If a mild or moderate reaction occurs, slow the infusion and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed.
- If a severe reaction such as anaphylaxis occurs, stop the infusion and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

1. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
2. Intubate for airway edema not rapidly responsive to epinephrine
3. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
4. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

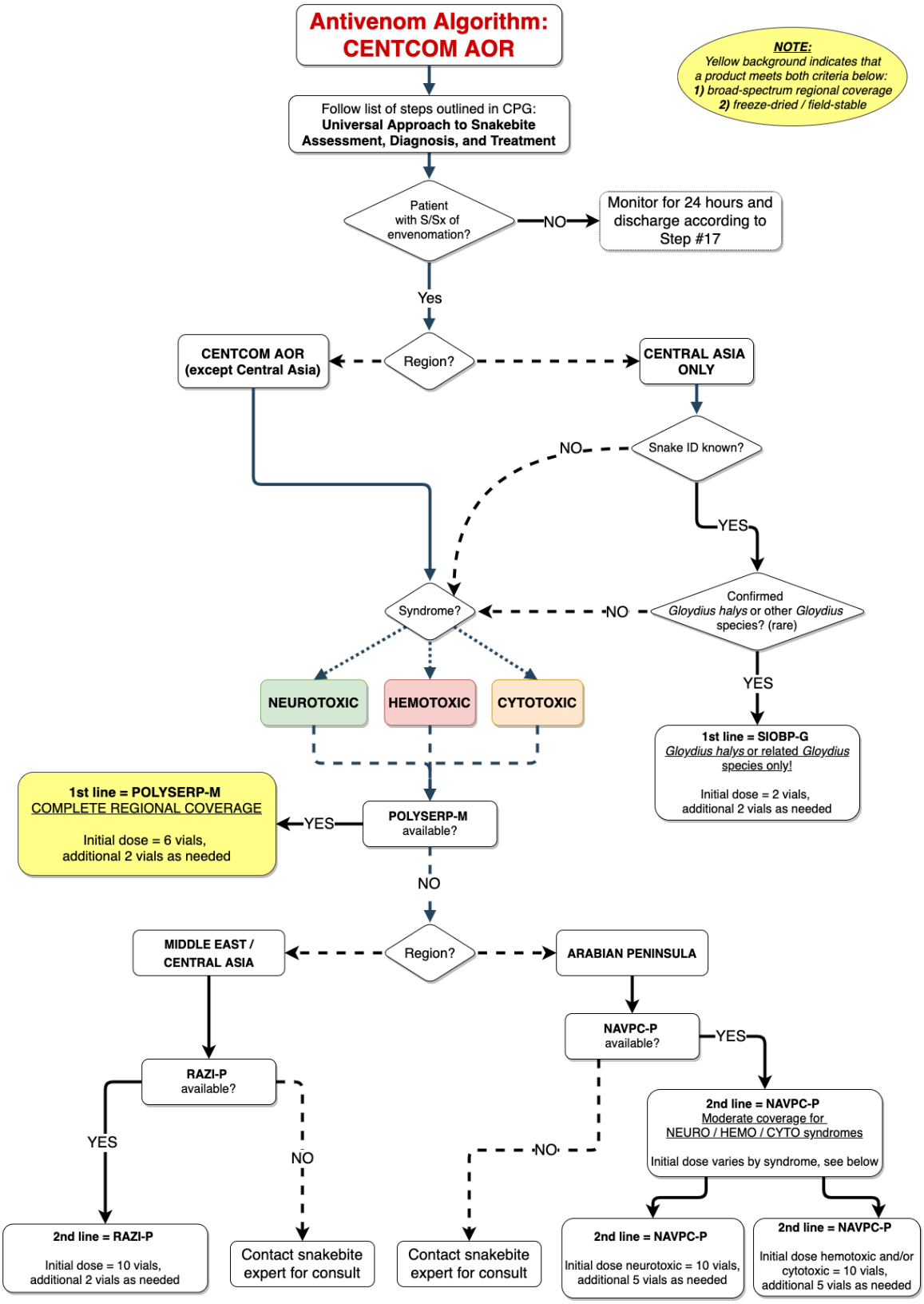
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 5. CENTCOM - First Line Antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	Additional doses if: persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until indications of improvement begin to appear (↑SBC, ↑LOC, ↑strength, etc.)	Additional doses if: persistence, resumption, or new onset of any active external or internal bleeding **OR** S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT	Additional doses if: significant increase in edema (such as beyond major joint) **OR** significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)
CENTCOM 1st Line Antivenoms	CENTCOM: Broad-spectrum coverage for all neurotoxic/hemotoxic/cytotoxic snakebite syndromes by known* or unknown species - POLYSERP-M: Initial dose = 6 vials regardless of severity / Additional doses = 2 vials as needed Central Asia: *If patient has a confirmed Gloydius halys bite (rare!), use SIOBP-G as 1st line if available. If unavailable or unconfirmed ID give POLYSERP-M - SIOBP-G: Initial dose = 2 vials / Additional doses = 2 vials as needed		
Antivenom Abbreviations	**POLYSERP-M** = POLYSERP MENA **SIOPB-G** = Gloydius halys monovalent		

Figure 3. Antivenom Algorithm for CENTCOM AOR


Antivenom Algorithm: CENTCOM AOR
NOTE: Yellow background indicates that a product meets both criteria below: 1) broad-spectrum regional coverage 2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
Yes
Region?
CENTCOM AOR (except Central Asia)
CENTRAL ASIA ONLY
Snake ID known?
NO
YES
Syndrome?
NO
Confirmed Gloydius halys or other Gloydius species? (rare)
YES
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
1st line = SIOBP-G
Gloydius halys or related Gloydius species only!
Initial dose = 2 vials, additional 2 vials as needed
1st line = POLYSERP-M
COMPLETE REGIONAL COVERAGE
Initial dose = 6 vials, additional 2 vials as needed
YES
POLYSERP-M available?
NO
Region?
MIDDLE EAST / CENTRAL ASIA
ARABIAN PENINSULA
RAZI-P available?
YES
NO
NAVPC-P available?
YES
NO
2nd line = NAVPC-P
Moderate coverage for NEURO / HEMO / CYTO syndromes
Initial dose varies by syndrome, see below
2nd line = RAZI-P
Initial dose = 10 vials, additional 2 vials as needed
Contact snakebite expert for consult
Contact snakebite expert for consult
2nd line = NAVPC-P
Initial dose neurotoxic = 10 vials, additional 5 vials as needed
2nd line = NAVPC-P
Initial dose hemotoxic and/or cytotoxic = 10 vials, additional 5 vials as needed

FIRST LINE CENTCOM - Arabian Peninsula/Middle East/Central Asia: POLYSERP-M

POLYSERP / Inosan, Spain - POLYSERP MENA Polyvalent (POLYSERP-M) (Freeze dried/Unrefrigerated) [162–172]

1. Field-stable. Broad-spectrum coverage 27+ species of Cyto/Hemo/Neuro.
2. Single source treatment option for all neurotoxic, hemotoxic, and cytotoxic snake envenomations in the Arabian Peninsula, the Middle East, and Central Asia when the causative species is either unknown or among the 27 snakes for which this product is directly indicated. Directly or indirectly covers all WHO category 1 species in the region. Directly or indirectly covers all category 2 snakes in this region for which an antivenom currently exists except for *Gloydius halys*, which is covered by Shanghai SIOBP-G or Iranian RAZI-P. Paraspecific neutralization against *Gloydius* unknown but not anticipated.
3. Initial dose = 6 vials all syndromes, additional doses = 2 vials as needed.

Feasibility of use in austere environments: Recommended for use in operational settings and specifically designed to fill the capability gap for ground medics operating in these areas. Updated version of Inoserp MENA made specifically for the austere and operational medicine environment. Freeze-dried, unrefrigerated, stable at temperatures >100º F for at least 180 days without loss of efficacy. Broad coverage and simple dosing enable administration in the field for any symptomatic snakebite by unknown species in this region. Special operations and conventional units deploying to austere operational environments and areas with critical threat venomous species should carry 8 vials per medic. It is recommended that a reserve quantity is stocked in all role 2 and role 3 facilities in AFRICOM in case additional antivenom is needed upon arrival, and also to restock field medics that have used their supply.

Adverse reactions: High efficacy against all major syndromes and low incidence of serious adverse reactions of approximately 1% based on current publications.

Indications: Broad spectrum polyvalent directly indicated for the treatment of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes caused by 27 different species of Middle Eastern, North African, and Central Asian snakes from the families *Elapidae* and *Viperidae*. First line for snake envenomations in this region when the causative species is unknown or among the species for which the product is directly indicated.

- NEUROTOXIC: Naja haje, N. oxiana; Walterinnesia aegyptia
- CYTOTOXIC and/or HEMOTOXIC: *Bitis arietans; Cerastes cerastes, C. vipera, C. gasperettii; Daboia palestinae, D. mauritanica, D. deserti; Echis. carinatus sochureki, E. coloratus, E. khosatskii, E. leucogaster, E. megalocephalus, E. omanensis, E. pyramidum; Macrovipera lebetina obtusa, M. l. transmediterranea, M. l. turanica; Montivipera bornmuelleri, M. raddei kurdistanica; Naja nubiae, N. pallida; Pseudocerastes persicus persicus, P. fieldi; Vipera latastei*

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 6 vials
- HEMOTOXIC initial dose = 6 vials
- CYTOTOXIC initial dose = 6 vials

Additional dosing: Additional doses of 2 vials POLYSERP-M may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Reconstitute every 2 vials of POLYSERP-M in the same 10 mL syringe by mixing the first vial, drawing it back up into syringe, and injecting it into the second vial to yield 2 vials/1 syringe (6 vial dose = 3 syringes total). Administer sequentially via slow, continuous direct IV or IO push over approximately 2

minutes each. If a reaction occurs stop the push, treat the reaction, reassess response to treatment criteria. Dilute remaining dose in a 100 mL bag of isotonic fluids and administer via slow IV or IO infusion over 30 mins if needed.

Direct push is recommended for convenience, but POLYSERP-M may also be administered via IV or IO infusion. Mix in a 50 mL or 100 mL bag of isotonic fluids and administer the entire bag over 5 – 10 mins.

FIRST LINE & SECOND LINE CENTCOM - Middle East/Central Asia: SIOBP-G

Shanghai Institute of Biological Products, China - Agkistrodon (Gloydius) halys Monovalent Antivenom (SIOBP-G): (Liquid/Refrigerated)[194–196]:

NOTE: This product is listed as Agkistrodon halys on the SIOBP website and product packaging but the taxonomy for this species has changed. Agkistrodon halys was moved to the genus *Gloydius* and should be listed as Gloydius *halys* as it is listed elsewhere. The product is abbreviated as SIOBP-G in the CPGs to account for this correction.

1. Not field stable. Not broad-spectrum. Single species coverage.
2. Monovalent for the WHO category 2 species *Gloydius halys*. Indicated as first line only for confirmed envenomation by *Gloydius halys* or related *Gloydius* species. Indicated as second line for unknown cytotoxic and/or hemotoxic envenomation in Middle East or Central Asia with no signs of improvement after 10 vials of POLYSERP-M. Does not provide coverage against any other WHO category 1 or category 2 species.
3. Initial dose = 6 vials hemotoxic/cytotoxic only, additional doses = 2 vials as needed.

First line (CENTCOM - MIDDLE EAST / CENTRAL ASIA): Monovalent for the WHO category 2 species *Gloydius halys.* Indicated only for confirmed envenomation by *Gloydius halys* or related *Gloydius* species. Does not provide coverage against any other WHO category 1 or category 2 species.

Second line (CENTCOM - MIDDLE EAST / CENTRAL ASIA): Indicated for unknown cytotoxic and/or hemotoxic envenomation in Middle East or Central Asia with no signs of improvement ***after 10 vials of POLYSERP-M.***

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration. Recommend storing small quantities at strategically located Role 2 & 3 facilities in CENTCOM AOR.

Incidence of adverse reactions: Low to moderate rates of EARs and serum sickness are anticipated but clinical evidence is limited.

Indications: This monovalent can be used to treat cytotoxic and hemotoxic envenomations by *Gloydius halys*, a pit viper native to the Middle East and Central Asia. It will most likely neutralize venom from related species in the genus Gloydius through paraspecificity, but this has not been tested in detail. There are several publications indicating that it may also have paraspecificity against some of the Southeast Asian green pit vipers from the genera *Cryptelytrops* and *Trimeresurus.*[196,197] However, it is not currently indicated by the manufacturer for these species.

- HEMOTOXIC AND/OR CYTOTOXIC: *Gloydius halys*

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC initial dose = 2 vials
- CYTOTOXIC initial dose = 2 vials

Additional dosing: Additional doses of 2 vials SIOBP-G may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

SECOND LINE CENTCOM - Middle East/Central Asi): RAZI-P

Razi Serum and Vaccine Research Institute, Islamic Republic of Iran - Polyvalent Snake Antivenom (RAZI-P) (Liquid/refrigerated)[198-205]**:**

1. Not field stable. Broad-spectrum coverage 6+ species Cyto/Hemo/Neuro.
2. Unknown neurotoxic, hemotoxic, or cytotoxic envenomation with no indications of improvement after 10 vials of POLYSERP-M. Directly or indirectly covers all WHO category 1 species in the region. Directly or indirectly covers some of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration. Recommend storing small quantities at strategically located Role 2 & 3 facilities in CENTCOM AOR or selecting alternative second line from this CPG.

Adverse reactions: Limited evidence but appears to be low based on current publications.

Indications: This polyvalent can be used to treat neurotoxic and cytotoxic envenomations by 6 different species of Middle Eastern, North African, and Central Asian snakes. It may be able to neutralize venom from additional species through paraspecific neutralization, but this has not been researched. The 6 species listed below are the official treatment indications recommended by the manufacturer:

- NEUROTOXIC: *Naja oxiana*
- HEMOTOXIC and/or CYTOTOXIC: *Pseudocerastes persicus fieldi, Echis carinatus, Vipera albicornuta, Vipera lebetina obtusa, Agkistrodon (Gloydius) halys*

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 10 vials
- HEMOTOXIC initial dose = 5 vials
- CYTOTOXIC initial dose = 5 vials

Additional dosing: Additional doses of 5 vials RAZI-P may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

SECOND LINE CENTCOM - Arabian Peninsula: NAVPC-C

National Antivenom & Vaccine Production Center, Saudi Arabia - Polyvalent Snake Antivenom (NAVPC-P) (Liquid/Refrigerated) [187-192] :

1. Not field stable. Broad-spectrum coverage 6+ species of Neuro/Hemo/Cyto.
2. Unknown neurotoxic, hemotoxic, or cytotoxic envenomation with no indications of improvement after 10 vials of POLYSERP-M. Only for Arabian Peninsula, very limited utility further East. Directly or indirectly covers some of the WHO category 1 and category 2 snakes in this region for which an antivenom currently exists.
3. Initial dose neuro = 10 vials. Initial dose hemo/cyto = 5 vials. All additional doses = 5 vials.

Feasibility of use in austere environments: Not recommended for operational settings. Requires refrigeration, moderate to high rates of adverse reactions are anticipated. Better alternatives exist. If purchased, it should be kept at Role 2 & 3 facilities in the Arabian Peninsula.

Adverse reactions: Insufficient evidence to determine risk of adverse reactions at this time.

Indications: This polyvalent can be used to treat neurotoxic and cytotoxic envenomations by 6 different species of Middle Eastern, North African, and Central Asian snakes. It may be able to neutralize venom from additional species through paraspecific neutralization, but this has not been researched. The 6 species listed below are the official treatment indications recommended by the manufacturer:

- NEUROTOXIC: *Walterinnesia aegyptia, Naja haje*
- HEMOTOXIC and/or CYTOTOXIC: *Bitis arietans, Echis coloratus, Echis carinatus, Cerastes cerastes*

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 10 vials
- HEMOTOXIC initial dose = 5 vials
- CYTOTOXIC initial dose = 5 vials

Additional dosing: Additional doses of 5 vials NAVPC-C may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: RECOMMENDED for this antivenom due to insufficient evidence for determining risk of EARs. Administer 0.25 mg epinephrine injected SQ prior to beginning antivenom infusion to reduce the risk of a serious reaction. Pediatric doses should be weight based at a dose of 0.01 mg/kg, up to 0.25 mg.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

EUCOM

Treatment Guidelines

Safe and effective broad-spectrum, refrigerated antivenoms are available for all three syndromes of snake envenomation due to European viper species in this AOR and treatment does not require identification of the species responsible. Snakebite treatment at the point of injury is not routinely recommended for EUCOM. This section provides specifics about antivenoms use in this region

ADVERSE REACTION MANAGEMENT

- If a mild or moderate reaction occurs, slow the infusion and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed.
- If a severe reaction such as anaphylaxis occurs, stop the infusion and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

4. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
5. Intubate for airway edema not rapidly responsive to epinephrine
6. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
7. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

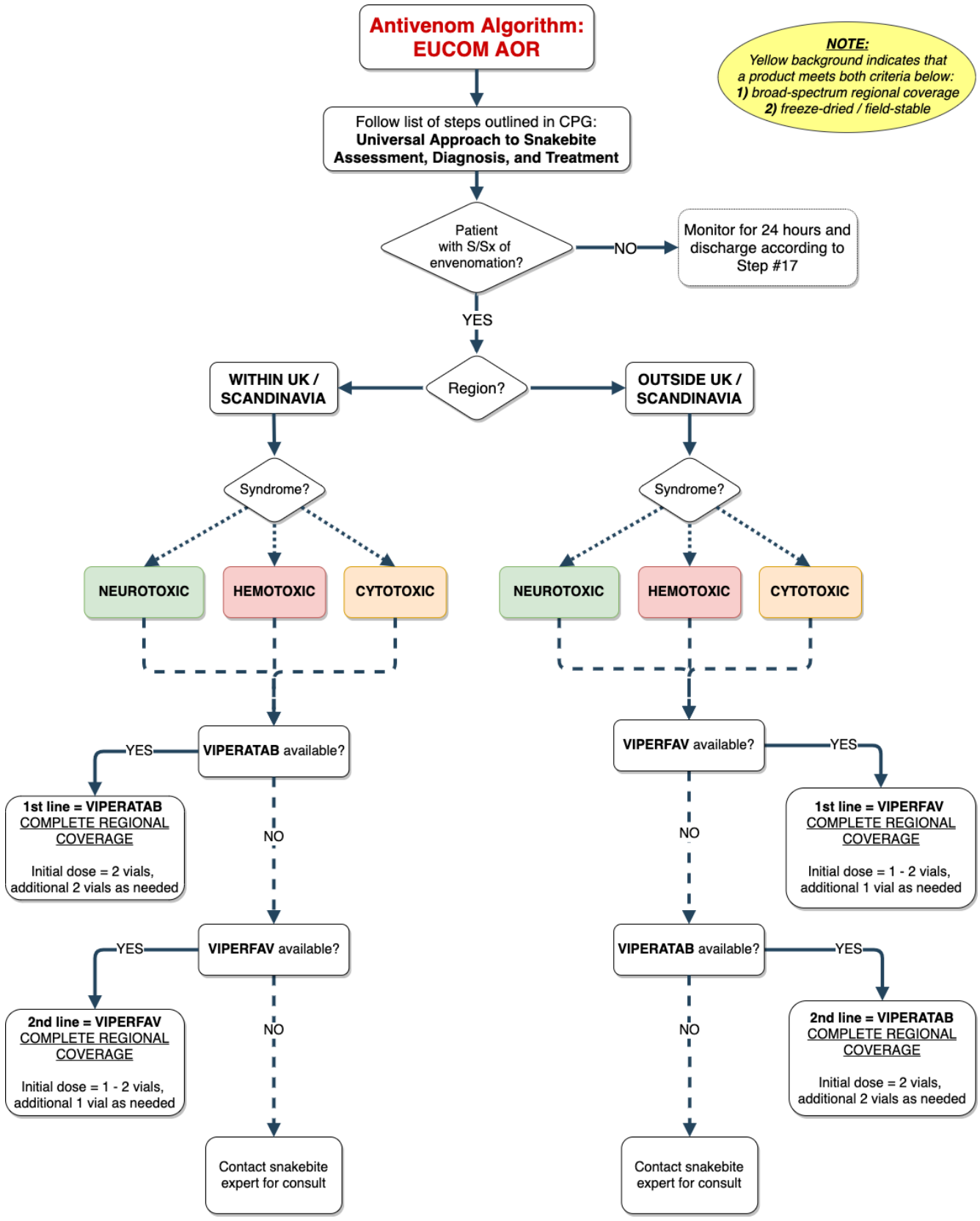
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 6. EUCOM First Line Antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc.); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	*Additional doses if:* *persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until signs of improvement begin to appear* (↑SBC, ↑LOC, ↑strength, etc.)	*Additional doses if:* *persistence, resumption, or new onset of any active external or internal bleeding* ***OR*** *S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT*	*Additional doses if:* *significant increase in edema (such as beyond major joint)* ***OR*** *significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)*
EUCOM 1st Line Antivenoms	UK or Scandinavia**:** Broad-spectrum coverage all neurotoxic/hemotoxic/cytotoxic syndromes from European Vipera species - VIPERATAB (1st line): Initial dose = 2 vials (one box), additional doses = 1 – 2 vials as needed - VIPERFAV (2nd line): Initial dose = 1 – 2 vials, additional doses = 1 vial as needed Outside UK/Scandinavia: Broad-spectrum coverage all neurotoxic/hemotoxic/cytotoxic syndromes from European Vipera species - VIPERFAV (1st line): Initial dose = 1 – 2 vials, additional doses = 1 vial as needed - VIPERATAB (2nd line): Initial dose = 2 vials (one box), additional doses = 1 – 2 vials as needed		
Antivenom Abbreviations	**VIPERFAV =** VIPERFAV **VIPERATAB** = ViperaTAb		

Figure 4. Antivenom Algorithm: EUCOM AOR


Antivenom Algorithm: EUCOM AOR
NOTE:
Yellow background indicates that a product meets both criteria below:
1) broad-spectrum regional coverage
2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
YES
Region?
WITHIN UK / SCANDINAVIA
OUTSIDE UK / SCANDINAVIA
Syndrome?
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
VIPERATAB available?
YES
1st line = VIPERATAB COMPLETE REGIONAL COVERAGE
Initial dose = 2 vials, additional 2 vials as needed
NO
VIPERFAV available?
YES
2nd line = VIPERFAV COMPLETE REGIONAL COVERAGE
Initial dose = 1 - 2 vials, additional 1 vial as needed
NO
Contact snakebite expert for consult
VIPERFAV available?
YES
1st line = VIPERFAV COMPLETE REGIONAL COVERAGE
Initial dose = 1 - 2 vials, additional 1 vial as needed
NO
VIPERATAB available?
YES
2nd line = VIPERATAB COMPLETE REGIONAL COVERAGE
Initial dose = 2 vials, additional 2 vials as needed
NO
Contact snakebite expert for consult

FIRST LINE EUCOM - Outside UK/Scandinavia: VIPERFAV

SECOND LINE EUCOM - Inside UK/Scandinavia: VIPERFAV

Sanofi-Pasteur, France - Viperfav (VIPERFAV) (Freeze dried/Refrigerated) [206-212]:

1. Not field-stable. Broad-spectrum coverage against multiple European vipers.
2. **First line treatment option (EUCOM - EUCOM OUTSIDE UK / SCANDINAVIA)**: Single-source treatment option for neurotoxic, hemotoxic, and cytotoxic snake envenomations by the most medically and epidemiologically significant species in Europe (*Vipera berus, V. aspis, V. ammodytes*) with paraspecific coverage against other European Vipera species. Can be used in the EUCOM AOR when the causative species is unknown or species for which this product is directly indicated.
3. **Second line treatment option (EUCOM - UK / SCANDINAVIA)** for all neurotoxic, hemotoxic, and cytotoxic snake envenomations within the UK and Scandinavia if first line (VIPERATAB) is not available.
4. Initial dose = 1 – 2 vials all syndromes, additional doses = 1 vial as needed.

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration between 2 - 8 ºC (35.6 - 46.4 ºF). Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities. Likely to retain efficacy for several weeks in the field but should be disposed of after that duration of time outside refrigeration.

Adverse reactions: High efficacy against all major syndromes and low incidence of serious adverse reactions based on current publications.

Indications: Polyvalent antivenom directly indicated for the treatment of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes caused by *Vipera berus, V. aspis, V. ammodytes* but has demonstrated efficacy against other species of European vipers (genus Vipera) as well.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 2 vials
- HEMOTOXIC initial dose = 1 - 2 vials
- CYTOTOXIC initial dose = 1 - 2 vials

Additional dosing: Additional doses of 1 vial VIPERFAV may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE EUCOM – Inside UK/Scandinavia: VIPERATAB

SECOND LINE EUCOM – Outside UK/Scandinavia: VIPERATAB

Micropharm, UK - ViperaTAb (VIPERATAB) (Freeze dried/Refrigerated) [206,210,213–215]:

1. Not field stable. Broad-spectrum coverage against several European vipers.
2. **First line (EUCOM - UK / SCANDINAVIA):** Single-source treatment option for neurotoxic, hemotoxic, and cytotoxic snake envenomations by the most medically and epidemiologically significant species in the UK and Scandinavia (Vipera berus) with paraspecific coverage against some other European Vipera species.
3. **Second line treatment option (EUCOM - OUTSIDE OF UK / SCANDINAVIA)** for all neurotoxic, hemotoxic, and cytotoxic snake envenomations in the EUCOM AOR outside of the UK and Scandinavia if first line (VIPERFAV) is not available.
4. Initial dose = 2 vials all syndromes, additional doses = 2 vials as needed. Each box = 2 vials.

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration between 2 - 8 ºC (35.6 - 46.4 ºF). Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities. Likely to retain efficacy for several weeks in the field but should be disposed of after that duration of time outside refrigeration.

Adverse reactions: High efficacy against UK / Scandinavian European viper (*Vipera berus*) envenomations and low incidence of serious adverse reactions based on current publications.

Indications: Polyvalent antivenom directly indicated for the treatment of neurotoxic, hemotoxic, and cytotoxic envenomation syndromes caused by *Vipera berus*. Has demonstrated efficacy against other species of European vipers (*V. aspis, V. ammodytes*) as well but is not directly indicated for these species.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 2 vials
- HEMOTOXIC initial dose = 2 vials
- CYTOTOXIC initial dose = 2 vials

Additional dosing: Additional 2 vials VIPERATAB may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Each box of VIPERATAB comes with two 4 mL vials of antivenom (one box = one dose). Dilute the entire dose of antivenom in a single 100 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

INDOPACOM
Treatment Guidelines

Safe and effective broad-spectrum, field-stable antivenoms are available for all three syndromes of snake envenomation in Southeast Asia and several other areas within this AOR. Snakebite treatment in INDOPACOM as a whole is more complex than AFRICOM or CENTCOM due to the lack of a truly pan-Asian polyvalent product. Treatment in many places does not require identification of the species responsible, but products are syndrome specific and there is no single product for all 3 syndromes. Snakebite treatment at the point of injury is recommended for areas within the INDOPACOM AOR where field-stable antivenoms are available. This section provides specifics about antivenoms use in this region.

ADVERSE REACTION MANAGEMENT

- If a mild or moderate reaction occurs, slow the infusion and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed.
- If a severe reaction such as anaphylaxis occurs, stop the infusion, and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

1. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
2. Intubate for airway edema not rapidly responsive to epinephrine
3. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
4. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

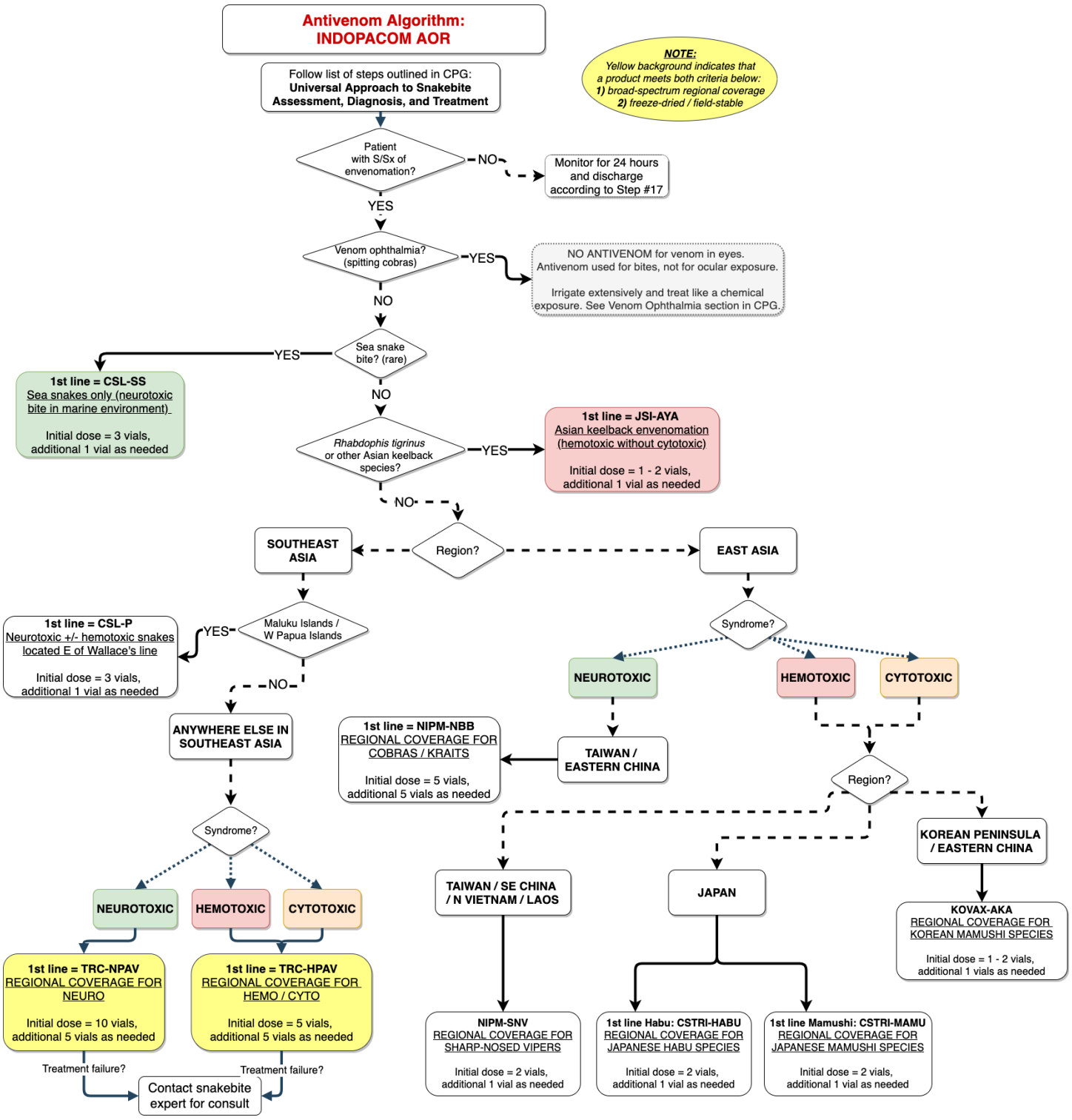
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 7. Indo-Pacific Command –First Line Antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	*Additional doses if: persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until signs of improvement begin to appear* (↑SBC, ↑LOC, ↑strength, etc.	*Additional doses if: persistence, resumption, or new onset of any active external or internal bleeding OR S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT*	*Additional doses if: significant increase in edema (such as beyond major joint) OR significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)*
INDOPACOM 1st Line Antivenoms	Southeast Asia: Broad-spectrum for all neurotoxic - *TRC-NPAV: Initial dose 10 vials* - *Additional doses = 5 vials as needed* TRC-NPAV is the 1st line for all neurotoxic bites in SE Asia outside of the circumstances listed below: Marine environments: Sea snake envenomations - *CSL-SS: Initial dose = 3 vials* - *Additional doses = 1 vial as needed* Maluku/West Papua islands: Neurotoxic - *CSL-P: Initial dose = 3 vials* - *Additional doses = 1 vial as needed* Eastern China/Taiwan: Neurotoxic - *NIPM-NBB: Initial dose = 5 vials* - *Additional doses = 5 vials as needed*	Southeast Asia: Broad-spectrum for all hemotoxic/cytotoxic (1st line in SE Asia) - TRC-HPAV: Initial dose = 10 vials, additional doses = 2 vials as needed. TRC-HPAV is the 1st line for all hemotoxic/cytotoxic bites in SE Asia outside of circumstances listed below: Korean Peninsula/Eastern China: Viper envenomations (Cytotoxic +/- Hemotoxic) Korean Mamushi species (Gloydius brevicaudus, G. ussuriensis, G. intermedius) - KOVAX-AKA: Initial dose = 1 - 2 vials, additional doses = 1 vial as needed Taiwan/Se China/N Vietnam/Laos: Sharp-nosed viper (Deinagkistrodon acutus) - NIPB-SNV: Initial dose = 2 vials, additional doses = 1 vial as needed Japan: Viper envenomations (Cytotoxic +/- Hemotoxic) If Japanese Habu (Protobothrops spp.) envenomation: - CSTRI-HABU: Initial dose = 1 -2 vials, additional doses = 1 vial as needed If Japanese Mamushi (Gloydius blomhoffi) envenomation: - CSTRI-MAMU: Initial dose = 1 -2 vials, additional doses = 1 vial as needed Japan/China/N & S Korea Vietnam/E Russia: Rhabdophis spp. - Hemotoxic without Cytotoxic Spontaneous bleeding develops within several days of bite without cytotoxicity. - JSI-AYA: Initial dose = 1 -2 vials, additional doses = 1 vial as needed	
Antivenom Abbreviations	**TRC-NPAV** = Neuro Polyvalent Antivenom **CSL-P** = CSL Polyvalent **CSL-SS** = CSL Sea Snake **NIPM-NBB** = Naja atra - Bungarus multicinctus Bivalent	**TRC-HPAV** = Hemato Polyvalent Antivenom **KOVAX-AKA** = Agkistrodon Mamushi Antivenom **JSI-AYA** = Anti-Yamakagashi Antivenom **CSTRI-HABU** = Kaketsuken Habu Antivenom **CSTRI-MAMU** = Kaketsuken Mamushi Antivenom **NIPM-SNV** = Sharp-nosed Viper Monovalent	

Figure 5. Antivenom Algorithm: INDOPACOM AOR


Antivenom Algorithm: INDOPACOM AOR
NOTE: Yellow background indicates that a product meets both criteria below: 1) broad-spectrum regional coverage 2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
YES
Venom ophthalmia? (spitting cobras)
YES
NO ANTIVENOM for venom in eyes. Antivenom used for bites, not for ocular exposure. Irrigate extensively and treat like a chemical exposure. See Venom Ophthalmia section in CPG.
NO
Sea snake bite? (rare)
YES
1st line = CSL-SS
Sea snakes only (neurotoxic bite in marine environment)
Initial dose = 3 vials, additional 1 vial as needed
NO
Rhabdophis tigrinus or other Asian keelback species?
YES
1st line = JSI-AYA
Asian keelback envenomation (hemotoxic without cytotoxic)
Initial dose = 1 - 2 vials, additional 1 vial as needed
NO
Region?
SOUTHEAST ASIA
EAST ASIA
Maluku Islands / W Papua Islands
YES
1st line = CSL-P
Neurotoxic +/- hemotoxic snakes located E of Wallace's line
Initial dose = 3 vials, additional 1 vial as needed
NO
ANYWHERE ELSE IN SOUTHEAST ASIA
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
1st line = TRC-NPAV
REGIONAL COVERAGE FOR NEURO
Initial dose = 10 vials, additional 5 vials as needed
1st line = TRC-HPAV
REGIONAL COVERAGE FOR HEMO / CYTO
Initial dose = 5 vials, additional 5 vials as needed
Treatment failure?
Treatment failure?
Contact snakebite expert for consult
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
1st line = NIPM-NBB
REGIONAL COVERAGE FOR COBRAS / KRAITS
Initial dose = 5 vials, additional 5 vials as needed
TAIWAN / EASTERN CHINA
Region?
TAIWAN / SE CHINA / N VIETNAM / LAOS
JAPAN
KOREAN PENINSULA / EASTERN CHINA
KOVAX-AKA
REGIONAL COVERAGE FOR KOREAN MAMUSHI SPECIES
Initial dose = 1 - 2 vials, additional 1 vials as needed
NIPM-SNV
REGIONAL COVERAGE FOR SHARP-NOSED VIPERS
Initial dose = 2 vials, additional 1 vial as needed
1st line Habu: CSTRI-HABU
REGIONAL COVERAGE FOR JAPANESE HABU SPECIES
Initial dose = 2 vials, additional 1 vial as needed
1st line Mamushi: CSTRI-MAMU
REGIONAL COVERAGE FOR JAPANESE MAMUSHI SPECIES
Initial dose = 2 vials, additional 1 vial as needed

FIRST LINE INDOPACOM - Southeast Asia: TRC-HPAV

Thai Red Cross, Thailand - Hemato Polyvalent Antivenom (TRC-HPAV) (Freeze dried/Unrefrigerated) [62,196, 197, 216–218]:

1. Field-stable. Broad-spectrum coverage multiple species of Hemo/Cyto.
2. Broad-spectrum treatment option for all hemotoxic and cytotoxic snake envenomations by known or unknown species in Southeast Asia. Best regional polyvalent.
3. Initial dose hemotoxic/cytotoxic only = 10 vials, additional doses = 5 vials as needed.

Feasibility of use in austere environments: Recommended for operational settings. Unrefrigerated storage at ambient tropical temperatures of ≤ 25º C / 77º F. Lyophilized product that likely retains stability at higher temperatures for short excursions (likely up to several months). Recommend carrying full dose into field on extended operations in austere environments and storing larger quantities at strategically located Role 2 & 3 facilities in INDOPACOM AOR.

Adverse reactions: High efficacy against and low incidence of serious adverse reactions based on current publications.

Indications: Polyvalent antivenom directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by *Calloselasma rhodostoma, Trimersurus albolabris*, and *Daboia russelli siamensis.* Has demonstrated efficacy against other related species of Asian vipers within the same genera (Crytelytrops, Popeia, Daboia, etc.); is not directly indicated for these species but is the best hemotoxic / cytotoxic polyvalent in the region and should be tried as first line in most cases.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC initial dose = 10 vials
- CYTOTOXIC initial dose = 10 vials

Additional dosing: Additional 2 vials TRC-HPAV may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE INDOPACOM - Southeast Asia Broad Spectrum Neurotoxic: TRC-NPAV

Thai Red Cross, Thailand - Neuro Polyvalent Antivenom (TRC-NPAV) (Freeze dried/Unrefrigerated) [62,196,217,219–221,]:

1. Field-stable. Broad-spectrum coverage multiple species of Neuro.
2. Broad-spectrum treatment option for all neurotoxic snake envenomations by known or unknown species in Southeast Asia. Best regional polyvalent.
3. Initial dose = 10 vials neurotoxic only, additional doses = 5 vials as needed.

Feasibility of use in austere environments: Recommended for operational settings. Unrefrigerated storage at ambient tropical temperatures of ≤ 25º C / 77º F. Lyophilized product that likely retains stability at higher temperatures for field excursions (likely stable for several months at higher temps based on data from similar

products). Recommend carrying full dose into field on extended operations in austere environments and storing larger quantities at strategically located Role 2 & 3 facilities in INDOPACOM AOR.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Polyvalent antivenom directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by *Ophiophagus hannah, Naja kaouthia, Bungarus candidus,* and *B. fasciatus candidus*. Has demonstrated efficacy against other related species of Asian cobras and kraits; is not directly indicated for these species but is the best hemotoxic / cytotoxic polyvalent in the region and should be tried as the first line in most cases.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 10 vials
  ***NOTE**: King cobra (O. hannah) bites likely to require much higher doses of antivenom due to massive venom yield; it is not unusual to require dozens of vials in these cases.*
- NOT INDICATED FOR HEMOTOXIC
- NOT INDICATED FOR CYTOTOXIC

Additional dosing: Additional 5 vials TRC-NPAV may be given at hours 2, 4, 6, 12, and 24 if needed. Bites from large king cobras may require several dozen vials or more due to massive venom yield.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE INDOPACOM – Taiwan/Southeast China/N Laos/N Vietnam: NIPM-NBB

National Institute Preventative Medicine, Taiwan - *Naja atra* / *Bungarus multicinctus* Bivalent (NIPM-NBB) (Freeze dried/Refrigerated) [222–230]:

1. Liquid product but field-stable for short excursions. Broad-spectrum coverage multiple species of Neuro.
2. Bivalent treatment option for neurotoxic cobra and krait envenomations in East Asia.
3. Initial dose = 5 vials neurotoxic only, additional doses = 5 vials as needed.

Feasibility of use in austere environments: Conditionally recommended for operational settings during short excursions. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); however, testing by Taiwanese CDC showed no loss of potency after 30 days of incubation at 35º C / 95º F and also after it was returned to refrigerated storage for 4 months thereafter. Recommend carrying full dose into field on extended operations in austere environments and storing larger quantities at regional Role 2 & 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Polyvalent antivenom directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by *Naja atra* and *Bungarus multicinctus.* Has demonstrated efficacy against other related species of Asian cobras and kraits but is not directly indicated for these species.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NEUROTOXIC initial dose = 5 vials
- NOT INDICATED FOR HEMOTOXIC
- NOT INDICATED FOR CYTOTOXIC

Additional dosing: Additional 5 vials NIPM-NBB may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 100 – 500 mL bag of isotonic solution and administer by intravenous infusion over 10 – 30 minutes.

FIRST LINE INDOPACOM - Japan: CSTRI-HABU

Chemo-Sero Therapeutic Research Institute, Japan - Kaketsuken Habu Antivenom (CSTRI-HABU)
(Freeze dried/Refrigerated) [231–235]:

1. Not field-stable. Not broad-spectrum. Habu coverage only.
2. First line treatment option for Habu envenomation (Protobothrops spp.).
3. Initial dose = 1 – 2 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); likely to retain efficacy for short excursions lasting several weeks in the field but should be disposed of and replaced after extended time outside refrigeration. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by the Japanese Habu (*Protobothrops [Trimeresurus] flavoviridis*)

Pretreatment: Not routinely Indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met; however, total reactions (~11% overall; ~25% serum sickness) higher than other regional products. Consider pretreatment on an individual basis.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC = 1 - 2 vials
- CYTOTOXIC = 1 - 2 vials

Additional dosing: Additional 1 vial CSTRI-HABU may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE INDOPACOM - Japan: CSTRI-MAMU

Chemo-Sero Therapeutic Research Institute, Japan - Kaketsuken Mamushi Antivenom (CSTRI-MAMU)
(Freeze dried/Refrigerated) [231–235]:

1. Not field stable. Not broad-spectrum. Japanese Mamushi coverage only.
2. First line treatment option for hemotoxic and cytotoxic envenomation syndromes caused by the Japanese Mamushi (*Gloydius blomhoffi*).

3. Initial dose = 1 – 2 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); likely to retain efficacy for short excursions lasting several weeks in the field but should be disposed of and replaced after extended time outside refrigeration. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by the Japanese Mamushi, *Gloydius blomhoffi*.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC = 1 - 2 vials
- CYTOTOXIC = 1 - 2 vials

Additional dosing: Additional 1 vial CSTRI-MAMU may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (INDOPACOM – Japan/China/N Korea/S Korea/Vietnam/E Russia): JSI-AYA

Japan Snake Institute, Japan - Anti-Yamakagashi Antivenom (JSI-AYA) (Freeze dried/Refrigerated) [231–233]:

1. Not field stable. Not broad-spectrum. Keelback coverage only.
2. First line treatment option for hemotoxic and cytotoxic envenomation syndromes caused by the Tiger Keelback (*Rhabdophis tigrinus*) and other East Asian keelback species.
3. Initial dose = 1 – 2 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); likely to retain efficacy for short excursions lasting several weeks in the field but should be disposed of and replaced after extended time outside refrigeration. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by the Tiger Keelback (*Rhabdophis tigrinus*) and other East Asian keelbacks.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC = 1 - 2 vials
- CYTOTOXIC = 1 - 2 vials

Additional dosing: Additional 1 vial JSI-AYA may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (INDOPACOM - N Korea/S Korea/E. China): KOVAX-AKA

Korea Vaccine, Korea - Agkistrodon Mamushi Antivenom (KOVAX-AKA) (Freeze dried/Refrigerated) [234–240]:

1. Not field stable. Not broad-spectrum. Korean Mamushi coverage only.
2. First line treatment option of hemotoxic and cytotoxic envenomation syndromes caused by the major species of Mamushi in the Korean Peninsula (*Gloydius brevicaudus, G. ussuriensis, G. intermedius*). May neutralize other related species.
3. Initial dose = 1 – 2 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); likely to retain efficacy for short excursions lasting several weeks in the field but should be disposed of and replaced after extended time outside refrigeration. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by the major species of Mamushi in the Korean Peninsula (*Gloydius brevicaudus, G. ussuriensis, G. intermedius*). May neutralize other related species.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC = 1 - 2 vials
- CYTOTOXIC = 1 - 2 vials

Additional dosing: Additional 1 vial KOVAX-AKA may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (INDOPACOM - Taiwan/SE China/N Vietnam/Laos): NIPM-SNV

National Institute Preventative Medicine, Taiwan - Sharp-nosed Viper Monovalent (NIPM-SNV) (Freeze dried/Refrigerated) [223,235–240:]

1. Freeze-dried product requiring cold chain but likely to be field-stable for short excursions. Not broad-spectrum. Sharp-nosed viper only.
2. First line monovalent antivenom directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by the sharp-nosed viper (*Deinagkistrodon acutus*).
3. Initial dose = 2 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Conditionally recommended for operational settings during short excursions. Lyophilized but requires cold chain refrigeration below 10ºC (50 ºF); however, testing by Taiwanese

CDC showed no loss of potency after 30 days of incubation at 35º C / 95º F and also after it was returned to refrigerated storage for 4 months thereafter. Recommend carrying full dose into field on extended operations in austere environments and storing larger quantities at regional Role 2 and 3 facilities.

Adverse reactions: High efficacy and low incidence of serious adverse reactions based on current publications.

Indications: Monovalent antivenom directly indicated for the treatment of hemotoxic and cytotoxic envenomation syndromes caused by *Deinagkistrodon acutus*.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC initial dose = 2 vials
- CYTOTOXIC initial dose = 2 vials

Additional dosing: Additional 1 vials NIPM-SNV may be given at hours 2, 4, 6, 12, and 24 if needed.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (INDOPACOM – Marine Environments Only): CSL-SS

Commonwealth Serum Laboratories, Australia - Sea Snake (CSL-SS) (Liquid/Refrigerated) [231-245] :

1. Not field stable. Broad-spectrum coverage against Indo-Pacific sea snakes only.
2. Neurotoxic envenomation in INDOPACOM by sea snakes or unknown species occurring in a strictly marine environment.
3. Initial dose = 3 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration between 2 - 8 ºC (35.6 - 46.4 ºF). Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities. Likely to retain efficacy for several weeks in the field but should be disposed of after that duration of time outside refrigeration.

Adverse reactions: High-quality product with low rates of reactions anticipated.

Indications: This polyvalent can be used to treat neurotoxic envenomations by most major species of sea snakes in Australasia.

Initial dosing by syndrome:

- NEUROTOXIC syndrome initial dose = 3 vials
- NOT INDICATED for hemotoxic envenomations
- NOT INDICATED for cytotoxic envenomations

Additional dosing: Additional doses of 1 vials CSL-SS may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (INDOPACOM – Maluku/West Papua Islands only): CSL-P

Commonwealth Serum Laboratories, Australia - Polyvalent (CSL-P) (Liquid/Refrigerated) [61, 241, 245-248]:

1. Not field stable. Broad-spectrum coverage.
2. First line antivenom indicated for neurotoxic/hemotoxic envenomation in INDOPACOM by Australasian elapids or unknown species occurring East of Wallace's line.
3. Initial dose = 3 vials, additional doses = 1 vial as needed

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration between 2 - 8 ºC (35.6 - 46.4 ºF). Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities. Likely to retain efficacy during short excursion at higher temperatures for several weeks in the field but should be disposed of and replaced afterwards.

Adverse reactions: High-quality product with low rates of reactions anticipated.

Indications: This polyvalent can be used to treat neurotoxic envenomations by the most medically significant species of Australasian elapid snakes found East of Wallace's line.

Initial dosing by syndrome:

- NEUROTOXIC syndrome initial dose = 3 vials
- HEMOTOXIC syndrome initial dose = 3 vials
- NOT INDICATED FOR CYTOTOXIC ENVENOMATIONS

Additional dosing: Additional doses of 1 vials CSL-P may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

NORTHCOM
Treatment Guidelines

Safe and effective antivenoms are available for all neurotoxic/hemo/cytotoxic pit viper envenomations and for neurotoxic coral snake envenomations in this AOR. Treatment does not require identification of the species responsible. Snakebite treatment at the point of injury is not routinely recommended for NORTHCOM.

For all NORTHCOM antivenoms, refer to the package insert in the antivenom box for specific usage instructions as per FDA regulations for domestically approved products. Also see Unified treatment algorithm for the management of crotaline snakebite in the U.S. (Lavonas et al. 2011) for dosing and management guidelines on pit viper bites.[101] This section provides specifics about antivenoms use in this region.

Adverse Reaction Management

- If a mild or moderate reaction occurs, slow the infusion, and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed.
- If a severe reaction such as anaphylaxis occurs, stop the infusion, and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

1. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
2. Intubate for airway edema not rapidly responsive to epinephrine
3. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
4. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

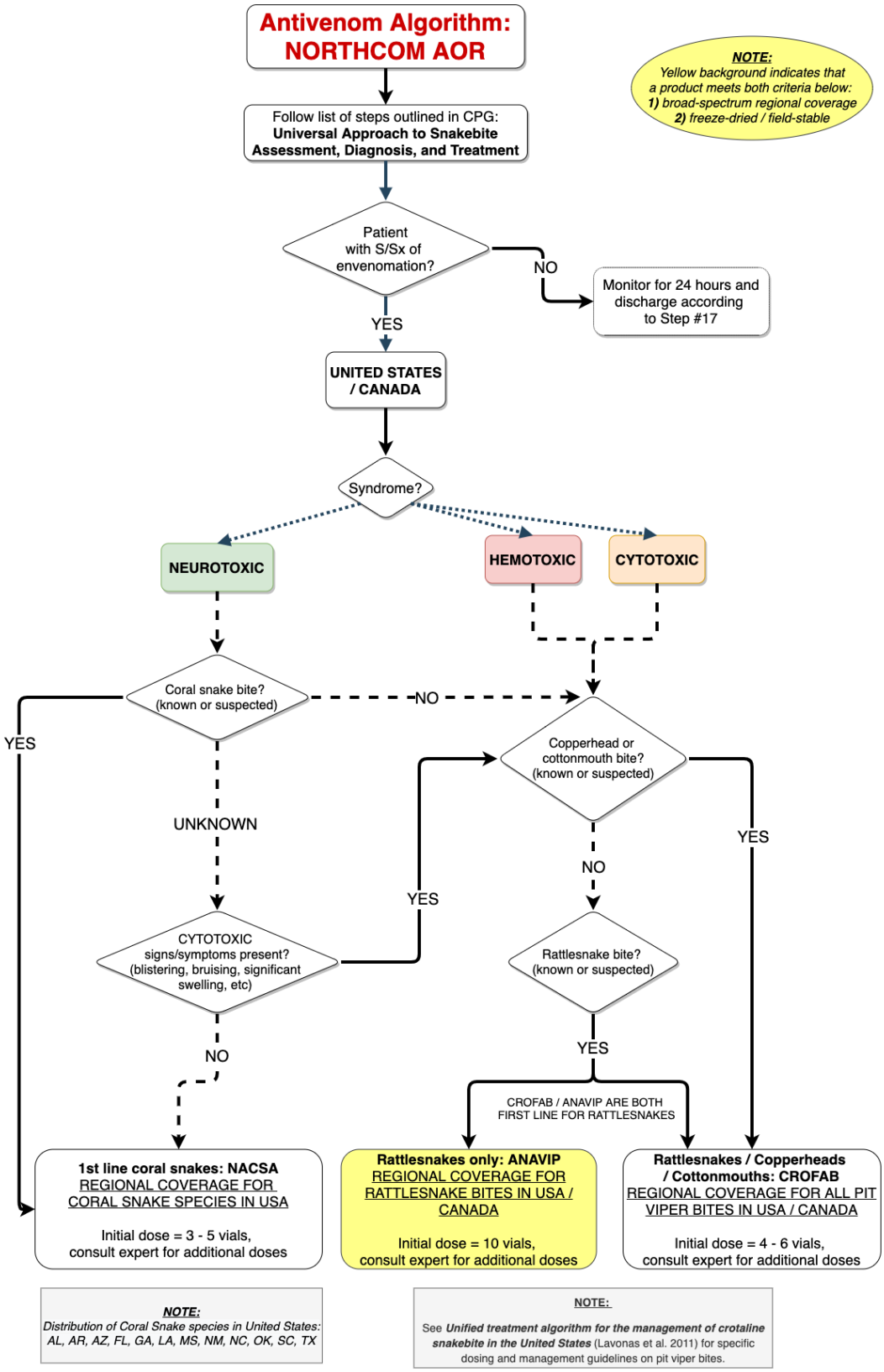
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 8. NORTHCOM- First Line Antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc.); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	Additional dose if: persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until signs of improvement begin to appear (↑SBC, ↑LOC, ↑strength, etc.)	Additional doses if: persistence, resumption, or new onset of any active external or internal bleeding **OR** S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT	Additional doses if: significant increase in edema (such as beyond major joint) **OR** significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)
NORTHCOM **1st Line Antivenoms**	U.S: Coral snake envenomations Initial 3-5 vials NACSA, additional doses not needed if 5 vial initial dose given U.S./Canada: Pit viper envenomations* - CROFAB: Initial dose = 4-6 vials, additional doses = 4-6 vial as needed - ANAVIP (rattlesnakes only): Initial dose = 10 vials, - additional doses = 10 vials as needed *Follow unified treatment algorithm	U.S./Canada: Broad spectrum coverage all hemotoxic/cytotoxic syndromes* Any pit viper envenomation (rattlesnake, copperhead, cottonmouth): - CROFAB: Initial dose = 4-6 vials, additional doses = 4-6 vials as needed Rattlesnake envenomations only: - ANAVIP: Initial dose = 10 vials, additional doses = 10 vials as needed NOTE: Anavip is only indicated by FDA for rattlesnake envenomations; not for copperheads or cottonmouths at this time; however, it is likely effective against all North American pit vipers. Follow Unified treatment algorithm for the management of crotaline snakebite in the U.S. (Lavonas et al. 2011) for dosing and management guidelines on pit viper bites.	
Antivenom Abbreviations	**CROFAB** = CroFab **ANAVIP** = ANAVIP **NACSA** = North American Coral Snake Antivenin		

Figure 6. Antivenom Algorithm: NORTHCOM AOR


Antivenom Algorithm: NORTHCOM AOR
NOTE: Yellow background indicates that a product meets both criteria below: 1) broad-spectrum regional coverage 2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
YES
UNITED STATES / CANADA
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
Coral snake bite? (known or suspected)
NO
YES
UNKNOWN
Copperhead or cottonmouth bite? (known or suspected)
YES
NO
CYTOTOXIC signs/symptoms present? (blistering, bruising, significant swelling, etc)
YES
Rattlesnake bite? (known or suspected)
NO
YES
CROFAB / ANAVIP ARE BOTH FIRST LINE FOR RATTLESNAKES
1st line coral snakes: NACSA
REGIONAL COVERAGE FOR CORAL SNAKE SPECIES IN USA
Initial dose = 3 - 5 vials, consult expert for additional doses
Rattlesnakes only: ANAVIP
REGIONAL COVERAGE FOR RATTLESNAKE BITES IN USA / CANADA
Initial dose = 10 vials, consult expert for additional doses
Rattlesnakes / Copperheads / Cottonmouths: CROFAB
REGIONAL COVERAGE FOR ALL PIT VIPER BITES IN USA / CANADA
Initial dose = 4 - 6 vials, consult expert for additional doses
NOTE: Distribution of Coral Snake species in United States: AL, AR, AZ, FL, GA, LA, MS, NM, NC, OK, SC, TX
NOTE: See Unified treatment algorithm for the management of crotaline snakebite in the United States (Lavonas et al. 2011) for specific dosing and management guidelines on pit viper bites.

BTG Therapeutics, USA – CroFab

(Freeze-dried/Refrigerated) [94,95,101,249-250] :

- **Indications:** Envenomation by all Pit Viper species (rattlesnakes, copperheads, cottonmouths) in North America. Freeze-dried; requires refrigeration but one study has demonstrated that it will maintain efficacy under field conditions for ≥ 90 days if needed.
- **Initial dosing:** 4 – 6 vials

RDT/Instituto Bioclon, USA/Mexico – ANAVIP

(Freeze-dried/Unrefrigerated) [92]

- **Indications:** Currently only indicated by FDA for rattlesnake envenomations.
- **Not currently indicated for copperhead or cottonmouth envenomations**, although this may change in the near future depending on results of upcoming studies. Freeze dried and field-stable at room temperature of 25º C / 77º F.
- **Initial dosing:** 10 vials

Pfizer, USA – North American Coral Snake Antivenom (NACSA)

(Freeze-dried/Refrigerated) [251]

- **Indications:** Indicated for neurotoxic envenomations by North American coral snake (NACSA) species in the United States including Eastern coral snake *(Micrurus fulvius)* and Texas coral snake *(Micrurus tener)*. Store between 2 – 8º C / 35.6 - 46.4 ºF; however, likely retains stability for short excursions in the field.
- **Initial dosing:** 5 vials

SOUTHCOM

Treatment Guidelines

Safe and effective antivenoms are available for all hemo/cytotoxic pit viper envenomations and for neurotoxic coral snake envenomations in this AOR. Treatment does not require identification of the species responsible but does require identification of the syndrome. Snakebite treatment at the point of injury is recommended for SOUTHCOM. This section provides specifics about antivenoms use in this region.

Adverse Reaction Management

- If a mild or moderate reaction occurs, slow the infusion, and treat symptomatically with antihistamines, steroids, and/or antiemetics as needed.
- If a severe reaction such as anaphylaxis occurs, stop the infusion, and treat according to the anaphylaxis protocol listed elsewhere in the CPG. Reassess the patient once the reaction has been controlled and resume the infusion at a slower rate if any of the specific criteria for antivenom treatment listed elsewhere in the CPG have not completely resolved.

Sudden Collapse Syndrome Treatment Protocol

Patient presents within 30 minutes of the bite with rapid onset shock ± angioedema, altered mental status, systemic bleeding, and diarrhea.[1]

5. Stabilize with IM or IV epinephrine and fluids as per anaphylaxis protocols
6. Intubate for airway edema not rapidly responsive to epinephrine
7. Follow epinephrine immediately with a high dose of the appropriate regional antivenom given by rapid IV or IO push during the resuscitation
8. Maintain blood pressure with IV or IO fluids and epinephrine until antivenom has taken effect to reverse the hypotension.

See Sudden Collapse Syndrome section for more information.

CONTACT

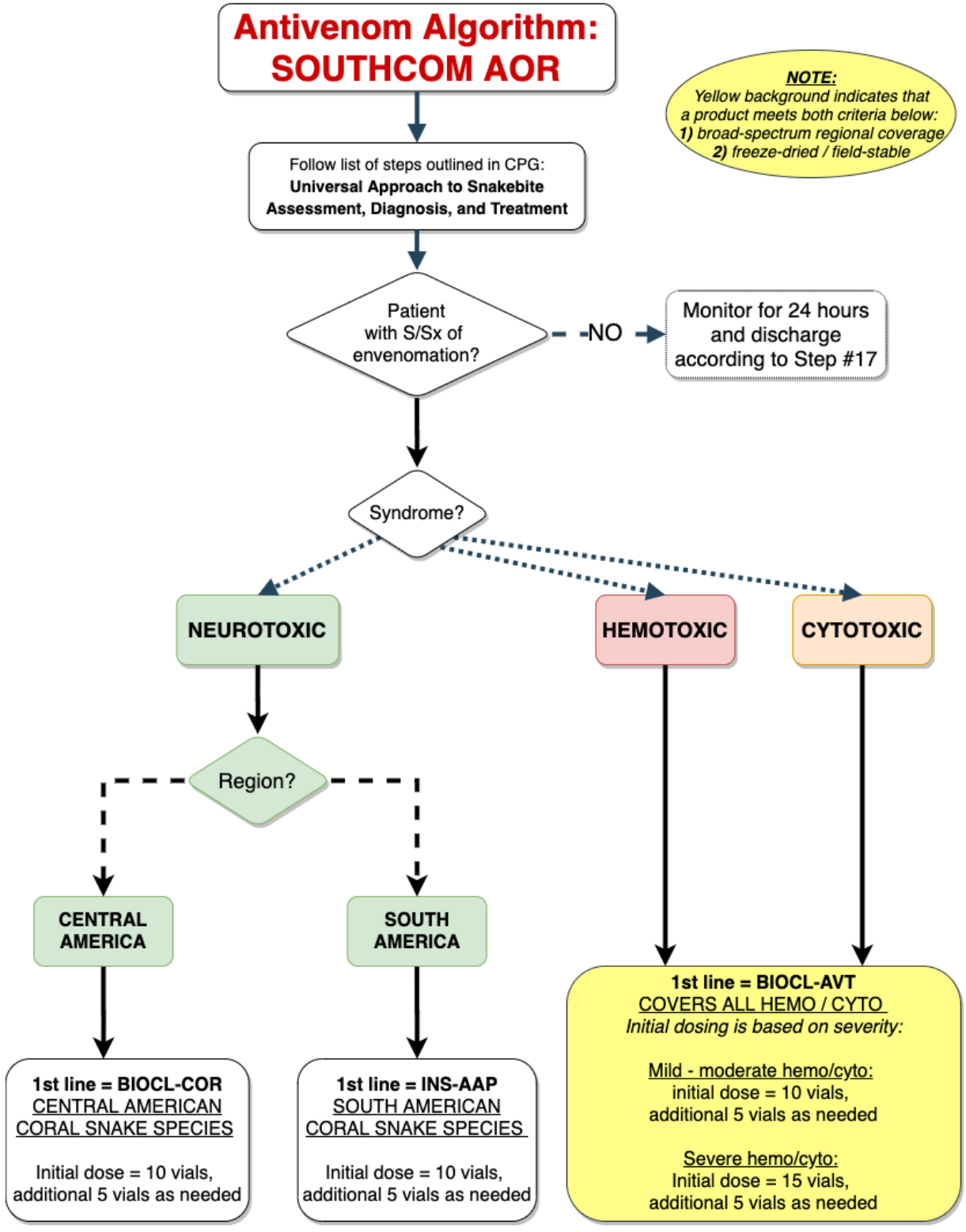
For emergency consultations, call the ADVISOR telemedicine hotline (866-972-9966) and select toxicology from the phone menu.

For additional information about snake bite management or this CPG, email jordan@snakebitefoundation.org or call 415-218-2211.

Table 9. SOUTHCOM - First line antivenoms

	Neurotoxic Syndrome	Hemotoxic Syndrome	Cytotoxic Syndrome
Mild	Local S/Sx (paresthesias; neuropathic pain; piloerection; muscle spasm, fasciculations)	Coagulopathy ± persistence of local bleeding from bite wound > 30 mins after bite	Severe pain; edema below elbow or knee; limited blistering within several inches of the bite wound
Moderate	Systemic S/Sx (bilateral ptosis GI symptoms; visual, auditory, or other sensory disturbances; widespread hyperesthesia)	Moderate systemic bleeding (old scabs, gingival bleeding, epistaxis, etc.); bruising distant from the bite wound	Edema above elbow or knee but not beyond shoulder or hip; moderate local blistering along bitten limb segment
Severe	Difficulty speaking; altered mental status; respiratory muscle weakness causing difficulty breathing; shock or otherwise unstable patient	Active GI bleed (usually hematemesis) or other internal bleeding; severe anemia; altered mental status; shock or otherwise unstable patient	Progressive edema beyond shoulder or hip; severe necrosis or widespread blistering; symptomatic bite to head, neck, or torso; altered mental status; shock or otherwise unstable patient
Criteria for additional AV doses at hours 2, 4, 6, 12, 24 (as needed)	<u>Additional doses if:</u> persistence or worsening of systemic neurotoxic S/Sx. Continue to re-administer 2 vial boluses as needed at hours 2, 4, 6, 12, and 24 until signs of improvement begin to appear (↑SBC, ↑LOC, ↑strength, etc.)	<u>Additional doses if:</u> persistence, resumption, or new onset of any active external or internal bleeding **OR** S/Sx of active venom confirmed by secondary recurrence of abnormal WBCT	<u>Additional doses if:</u> significant increase in edema (such as beyond major joint) **OR** significant increase in pain (severity of pain and/or how far pain radiates up the bitten limb)
SOUTHCOM 1st Line Antivenoms	Central America: Neurotoxic polyvalent - *BIOCL-COR: Any severity = initial 10 vials* - *Additional 5 vials as needed* South America: Neurotoxic polyvalent - *INS-AAP: Any Severity = 10 vials* - *Additional 5 vials as needed*	Central and South America: Broad-spectrum all hemotoxic/cytotoxic syndromes *BIOCL-AVT: Initial dosing is based on severity* - *<u>Mild – moderate:</u> Initial dose = 10 vials BIOCL-AVT* - *Additional doses = 5 vials as needed* - *<u>Severe:</u> Initial dose = 15 vials BIOCL-AVT* - *Additional doses = 5 vials as needed*	
Antivenom Abbreviations	**BIOCL-COR** = CORALMYN **INS-AAP** = Antiveneno Anticoral Polivalente **BIOCL-AVT** = Antivipmyn Tri		

Figure 7. Antivenom Algorithm: SOUTHCOM AOR


Antivenom Algorithm: SOUTHCOM AOR
NOTE:
Yellow background indicates that a product meets both criteria below:
1) broad-spectrum regional coverage
2) freeze-dried / field-stable
Follow list of steps outlined in CPG: Universal Approach to Snakebite Assessment, Diagnosis, and Treatment
Patient with S/Sx of envenomation?
NO
Monitor for 24 hours and discharge according to Step #17
Syndrome?
NEUROTOXIC
HEMOTOXIC
CYTOTOXIC
Region?
CENTRAL AMERICA
SOUTH AMERICA
1st line = BIOCL-COR
CENTRAL AMERICAN CORAL SNAKE SPECIES
Initial dose = 10 vials, additional 5 vials as needed
1st line = INS-AAP
SOUTH AMERICAN CORAL SNAKE SPECIES
Initial dose = 10 vials, additional 5 vials as needed
1st line = BIOCL-AVT
COVERS ALL HEMO / CYTO
Initial dosing is based on severity:
Mild - moderate hemo/cyto:
initial dose = 10 vials, additional 5 vials as needed
Severe hemo/cyto:
Initial dose = 15 vials, additional 5 vials as needed

FIRST LINE (Entire SOUTHCOM AOR): BIOCL-AVT

Instituto Bioclon, Mexico – ANTIVIPMYN-TRI (BIOCL-AVT) (Freeze dried/Unrefrigerated) [251-255]:

1. Field-stable. Broad-spectrum coverage 14 species Hemo/Cyto.
2. First line treatment option for all hemotoxic and cytotoxic snake envenomations anywhere in the SOUTHCOM AOR when the causative species is either unknown or among the ≥ 14 snakes for which this product is directly indicated. Directly or indirectly covers most of the WHO category 1 and category 2 snakes in this region.
3. Initial dose = 10 vials hemotoxic/cytotoxic only, additional doses = 5 vials as needed.

Feasibility of use in austere environments: Recommended for operational settings. Unrefrigerated storage at ambient tropical temperatures of ≤ 37º C / 98.6º F. Lyophilized product that likely retains stability at higher temperatures for short excursions. Recommend carrying full dose or loading dose (≥ 5 vials) into field on extended operations in austere environments and storing larger quantities at strategically located Role 2 & 3 facilities in SOUTHCOM AOR.

Adverse reactions: High-quality product with low rates of reactions anticipated.

Indications: This broad-spectrum polyvalent can be used to treat hemotoxic and cytotoxic envenomations by more than 14 different species of Central and South American snakes. It may be able to neutralize venom from additional species through paraspecific neutralization, but this has not been officially determined. The species listed below are the official treatment indications recommended by the manufacturer:

- HEMOTOXIC and/or CYTOTOXIC: *Crotalus durissis terrificus; Bothrops asper, B. atrox, B. neuwiedii, B. alternatus, B. jararacussu, B. venezulensis, B. pictus, B. brazili; Lachesis muta muta, L. m. stenophyrs; Sistrurus spp.; Agkistrodon spp*.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met.

Initial dosing by syndrome:

- NOT INDICATED FOR NEUROTOXIC
- HEMOTOXIC initial dose = 10 vials
- CYTOTOXIC initial dose = 10 vials

Additional dosing: Additional doses of 5 vials BIOCL-AVT may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (SOUTHCOM – Central America/South America): BIOCL-COR

SECOND LINE (SOUTHCOM – South America): BIOCL-COR

Instituto Bioclon, Mexico - CORALMYN (BIOCL-COR) (Liquid/Refrigerated) [256-262]:

1. Not field stable. Broad-spectrum coverage neuro in Central America.
2. First line treatment option for neurotoxic envenomation in Central America by coral snakes or unknown species (coral snakes are only strictly neurotoxic snakes in SOUTHCOM AOR). Second line treatment option for coral snake / unknown neurotoxic envenomation in South America if first line (INS-AAP) is not available.
3. Initial dose = 10 vials neurotoxic only, additional doses = 5 vials as needed.

First Line (SOUTHCOM – Central America): Neurotoxic envenomation in Central America by coral snakes or unknown species (coral snakes are only strictly neurotoxic snakes in SOUTHCOM AOR).

Second Line (SOUTHCOM – South America): May treat some coral snakes in South America but major coverage gaps in that region compared to the first line for South America (INS-AAP).

Feasibility of use in austere environments: Not recommended for operational settings. Requires cold chain refrigeration between 2 - 8 ºC (35.6 - 46.4 ºF). Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities in South America. Likely to retain efficacy for several weeks in the field but should be disposed of after that duration of time outside refrigeration.

Adverse reactions: High-quality product with low rates of reactions anticipated.

Indications: This polyvalent can be used to treat neurotoxic envenomations by most major species of Central American coral snakes from the genus *Micrurus*.

- NEUROTOXIC: Central American coral snakes (*Micrurus spp*.)

Initial dosing by syndrome:

- NEUROTOXIC syndrome initial dose = 10 vials
- NOT INDICATED FOR HEMOTOXIC ENVENOMATIONS
- NOT INDICATED FOR CYTOTOXIC ENVENOMATIONS

Additional dosing: Additional doses of 5 vials BIOCL-COR may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

FIRST LINE (SOUTHCOM – South America): INS-AAP

SECOND LINE (SOUTHCOM – Central America): INS-AAP

Instituto Nacional de Salud, Colombia - Antiveneno Anticoral Polivalente (INS-AAP) (Liquid/Refrigerated) [260-2]:

1. Not field stable. Broad-spectrum coverage Neuro in South America.
2. First line treatment option for neurotoxic envenomation in South America by coral snakes or unknown species (coral snakes are only strictly neurotoxic snakes in SOUTHCOM AOR). Second line treatment option for coral snake / unknown neurotoxic envenomation in Central America if first line (INS-AAP) is not available.
3. Initial dose = 10 vials neurotoxic only, additional doses = 5 vials as needed.

First Line (SOUTHCOM – South America): Broadest efficacy against neurotoxic snake bites by coral snakes or unknown species in South America. Coral snakes are the only strictly neurotoxic species in SOUTHCOM.

Second Line (SOUTHCOM – Central America): Should treat most coral snake species in Central America but will have some coverage gaps compared to the first line for Central America (BIOCL-COR).

Feasibility of use in austere environments: Not recommended for operational settings. Liquid product that requires cold chain refrigeration between 4 - 8 ºC / 39.2 - 46.4 ºF. Recommend storing several vials at a small number of strategically located Role 2 & 3 facilities in South America. Likely to retain efficacy for several weeks in the field but should be disposed of after that duration of time outside refrigeration.

Adverse reactions: High-quality product with low rates of reactions anticipated.

Indications: This polyvalent can be used to treat neurotoxic envenomations by most major species of South American coral snakes from the genus *Micrurus* as well as some Central American species.

- NEUROTOXIC: South American coral snakes (*Micrurus spp.)* including *Micrurus dumerilii, M. mipartitus, M. surinamensis, M. isozonus, M. lemniscatus, M. spixi, M. Medemi*

Initial dosing by syndrome:

- NEUROTOXIC syndrome initial dose = 10 vials
- NOT INDICATED FOR HEMOTOXIC ENVENOMATIONS
- NOT INDICATED FOR CYTOTOXIC ENVENOMATIONS

Additional dosing: Additional doses of 5 vials INS-AAP may be given at hours 2, 4, 6, 12, and 24 if needed.

Pretreatment: Not routinely indicated unless patient is unstable, asthmatic/atopic, known hypersensitivity or other pretreatment criteria met. Low risk of severe allergic reactions and other EARs.

Preparation and administration: Dilute the entire dose of antivenom in a single 250 - 500 mL bag of isotonic solution and administer by intravenous infusion over 10 - 30 minutes.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients injured by snakes.

INTENT (EXPECTED OUTCOMES)

1. All snakebite patients should be managed according to the steps outlined in the Universal Approach to Snakebite Assessment, Diagnosis, and Treatment section.
2. Assessment, diagnosis, and treatment of snakebite patients should be based on the clinical syndrome of envenomation and not the identity of the snake species responsible for the bite.

   When a broad-spectrum antivenom does not exist for a given syndrome in a given area, follow the steps outlined in the regional algorithms to determine the most appropriate antivenom therapy for the patient.
3. Snakebites are dynamic events and patients must be frequently reassessed for signs of neurotoxic, hemotoxic, and cytotoxic syndromes throughout the course of care as some syndromes will develop than others.
4. There are no absolute contraindications to antivenom administration for a patient with a symptomatic snake envenomation.
5. Antivenom administration should be performed by medical providers capable of providing advanced life support and trained to a minimum level of paramedic (or DoD equivalent) and higher (i.e. SOCM, 18D, PJ, IDC, IDMT, RN, PA, MD or DO, etc.)
6. Early antivenom treatment is the standard of care for snake envenomations worldwide. Whenever possible, the appropriate antivenom should be administered in the field prior to medevac to neutralize circulating venom before significant and potentially irreversible damage has occurred.
   - Field-stable, broad-spectrum antivenom options are included in this CPG for all combatant commands except for EUCOM.
   - Appropriate regional products listed in the CPG should be stocked in Role 2 and Role 3 medical facilities. Far-forward units with paramedic level providers should be equipped with field-stable, broad-spectrum antivenoms that can be stocked in the aid station and carried into the field for extended periods of times at high temperatures without loss of efficacy.
7. If antivenom is not available, the patient should be transferred to a facility that maintains a stock of the appropriate antivenom. Confirm that the receiving facility has the correct antivenom in stock prior to transfer. If the receiving facility does not have the correct product(s) in stock, then that facility should be bypassed for a facility that is stocking the appropriate products.
8. Antivenom dosage, preparation, and administration procedures for each product should be performed as detailed for each specific product.
9. Tetanus prophylaxis should be given prior to discharge when needed.
10. Fasciotomy is contraindicated for snakebite and all cases of suspected compartment syndrome should be managed with additional doses of antivenom and elevation ≥ 60 degrees to reduce oncotic pressure in the bitten limb.

11. Initiate a telemedicine consult with a qualified snakebite expert for any questions, concerns, or unusual manifestations that arise.
12. Do not attempt to kill or capture the snake for identification purposes as treatment is based on clinical findings. If a photo of the snake is available it can be sent to an expert for identification, but this should not delay antivenom treatment in a symptomatic patient with signs and symptoms of any envenomation syndrome.

PERFORMANCE/ADHERENCE METRICS

1. Administration of antivenom to any patients with clinical signs and symptoms of neurotoxic, hemotoxic, or cytotoxic envenomations
2. Early administration of appropriate antivenoms to symptomatic patients in the field
3. Rapid transfer of patients to a facility stocking the appropriate antivenom if not available on site
4. Antivenom administration should be performed by an advanced life support qualified provider trained to the paramedic level (or DoD equivalent) or higher
5. Tetanus prophylaxis as needed
6. Manage elevated intracompartmental pressures with antivenom and do not perform fasciotomies.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: WHOLE BLOOD CLOTTING TEST

Whole Blood Clotting Test for Venom-Induced Consumptive Coagulopathies

The whole blood clotting test (WBCT) is a simple but critical bedside gross examination used in the assessment, diagnosis, and therapeutic monitoring of snakebite patients in the developing world and remote environments.[1-10] Refer to the diagram below regarding instructions for performing the test. At minutes 20 and 30, the tube is gently picked up and tilted 90 degrees; a stable solid clot retained within the tube is scored "Grade 0" and indicates normal coagulation. Abnormal results are scored "Grade 1" for a partial, semisolid clot that breaks apart and detaches from the glass tube shortly after it is turned or "Grade 2" for completely incoagulable liquid blood that pours out of the tube immediately. Attempting to score the test earlier than 20 minutes will not yield accurate results due to the consumptive mechanism of the coagulopathy. Using a healthy donor as a control is ideal to confirm questionable findings.

Continue WBCT testing throughout the course of care to monitor for secondary resumption of venom-induced consumptive coagulopathy.[11-13] After control of the envenomation has been achieved, reassess WBCT every 24 hours throughout the course of hospitalization. It is important to remember that the WBCT must be interpreted in the context of the larger clinical picture. If a patient has improved in all parameters except for a persistent abnormal WBCT, it may reflect an inertia in replenishment of depleted clotting factors after a severe hemotoxic envenomation.[1] If the venom is active then hematocrit should continue to decrease or signs of ongoing hemolysis or bleeding should be present.

Whole Blood Clotting Test (WBCT)

Draw 2 mL of venous blood and transfer directly into a clean and dry glass tube. Leave it upright, open, undisturbed for 20 and/or 30 minutes at room temp.

Collection: a blood sample for WBCT testing immediately after collection.

After exactly 20 minutes, pick up the tube and invert it. If a solid clot is retained, the test indicates normal coagulation.

Normal: a solid clot is retaining upon inversion of the tube at 20 or 30 minutes (Grade 0, no coagulopathy).

If clot breaks down quickly upon inversion of the tube or fails to coagulate, the test indicates a coagulopathy.

Abnormal: clot degrades rapidly (Grade 1, friable clot) or fails to coagulate whatsoever (Grade 2).

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APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Global Spider and Scorpion Envenomation Management (CPG ID: 84)

This CPG provides an overview of spider and scorpion envenomation and presents a standardized approach to providers in the evaluation and treatment of patients with spider or scorpion induced poisoning.

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BACKGROUND

Spider and scorpion envenomations can occur in many environments in which the military operates.[1] While most spider and scorpion envenomations result in mild symptoms, severe toxicity and death can occur.

Arthropods are a diverse group of animals with numerous species producing a wide array of toxins. Many arthropods possess a significant venom but lack a sufficient apparatus (fangs or talon) to inject it into humans. Most bites and stings involve more danger from anaphylaxis, but several species of spiders and scorpions have significant neurotoxic, cytotoxic, or hemotoxic venoms. Unfortunately, reliable data evaluating the impact of spider bites and scorpion stings on humans are lacking. Most knowledge is based on case reports and case series, frequently lacking expert review. Furthermore, the public frequently spreads inaccurate information (i.e. reporting a skin abscess resulting from *Staph. aureus* is a "spider bite").

Unlike other types of injuries, patients may not even recognize they were envenomated by arthropods, as many injuries are painless or felt as a pinprick. Anaphylaxis is the most concerning initial effect. Recognize and treat it immediately using standard acute allergic reaction therapies. Anaphylaxis from an arthropod envenomation is not an indication for antivenom. For all bites/stings, assess tetanus status and administer vaccine and/or immunoglobulin (for those not previously immunized against tetanus) if required. The following section describes the more clinically significant species of venomous arthropods, the toxicological syndrome they produce, and the treatment. Consider toxicology consultation using the ADvanced VIrtual Support for OpeRational Forces (AD.VI.S.O.R) line in any patient with systemic symptoms secondary to a spider or scorpion envenomation – Commercial: 1 (833)-ADVSRLN (238-7756) or DSN (312) 429-9089.

SPIDERS

While many spider species produce venom, the vast majority lack sufficiently large or strong enough fangs to penetrate human skin and cause clinically significant effects. However, spiders venomous to humans can be found throughout much of the world. Appendix A provides the geographical location of clinically significant venomous spider species.

WIDOW SPIDERS (*LATRODECTUS* SPECIES)

BACKGROUND

Multiple species of widow spiders (*Latrodectus spp.*) are found on various continents (North America, Asia, Europe, Africa, and Australia). They are generally black or brown with a red or yellow demarcation on their ventral and/or dorsal abdomen. A lack of a red or yellow demarcation on the spider does not exclude it from being a *Latrodectus spp*. They live in temperate and tropical latitudes and tend to inhabit shady enclosed spaces such as crevices, wood piles, and sheds. Humans are commonly bitten while in bed during the fall and early winter when the spiders are attempting to find warmth.

PATHOPHYSIOLOGY

Widow spider venom consists of multiple toxins which ultimately result in activation of the nervous system and muscle contraction.[2]

CLINICAL MANIFESTATION

Patients may or may not feel a pinprick upon the initial bite. A pair of small red spots at the envenomation site may be visible; however, the bite site is often not located.[3] Some patients do not develop systemic toxicity. In those patients who do, symptoms typically begin 15 to 60 minutes following the envenomation. The primary symptom is painful muscle cramping, starting at the bite site and progressing towards the center of the body. Patients may develop a painful, rigid abdomen secondary to abdominal muscle spasm which may be mistaken for peritonitis. The pain increases over time and may occur in waves. In some cases, the patient develops a temporary diaphoretic, grimaced, and contorted appearance of the face referred to as "*facies latrodectismica*."[4] Other symptoms include vomiting, diaphoresis, tachycardia, hypertension (often profound), and restlessness. Symptoms of *Latrodectus* envenomation last hours to days. Fatalities from *Latrodectus* envenomation are exceedingly rare and, when they do occur, are secondary to cardiac arrest (presumably from severe hypertension in patients with predisposing medical conditions) and wound infection.[5]

TREATMENT

Treatment consists primarily of supportive care, pain management, and wound care (to include tetanus prophylaxis). Given the low risk of infection, antibiotics are not routinely recommended.

Depending upon the severity of pain, acetaminophen, nonsteroidal anti-inflammatory agents, and opioids can be used for pain control. Benzodiazepines may improve muscle spasms.[6] Pain control and benzodiazepines are often sufficient to manage tachycardia and hypertension. In those patients with severe pain refractory to pain medications, antivenom (if available) may be indicated but may not be readily available.[7] Long term injury or death from *Latrodectus* is extremely unlikely. While rare, fatal allergic reactions to *Latrodectus* antivenom have occurred.[8] Fatal cases due to antivenom anaphylaxis have been reported in patients with asthma. Therefore, *Latrodectus* antivenom is not indicated in patients with otherwise manageable symptoms, particularly those that may be at higher risk (i.e. history of asthma). If administered, patients should be monitored for 4 hours, but prophylactic treatment for allergic reaction is not recommended. When patients do have significant symptoms meeting indications for antivenom, the antivenom is rapidly effective and curative. When necessary, expired vials of antivenom may be used.[9] The dose consists of one 2.5 milliliter vial of antivenom dissolved in one 2.5 milliliter vial of sterile water (provided in the antivenom kit) administered intravenously. While the package instructions permit intramuscular injection, this route is unlikely to provide sufficient absorption to manage symptoms.[10] While one dose is usually sufficient, a second dose may be administered if symptoms are not adequately controlled 15-30 minutes after the first dose.

In the event that medical personnel are unable to control the patient's symptoms with available pain medications and benzodiazepines, then medical evacuation is recommended.

VIOLIN SPIDERS (*LOXOSCELES* SPECIES)

BACKGROUND

Loxosceles reclusa in a venomous spider more commonly known as the brown recluse, violin spider, or fiddleback spider. As indicated by the common names, the spider has a brown shape/mark resembling a violin or fiddle on the dorsum of its cephalothorax. The *Loxosceles* genus has a worldwide distribution. The spiders prefer dark areas such as wood piles, crevices between rocks, and basements. While not aggressive, they will bite if antagonized.[11]

PATHOPHYSIOLOGY

Loxosceles venom is cytotoxic (toxic to living cells) and consists of two main constituents: sphingomyelinase-D and hyaluronidase. Hyaluronidase facilitates the spreading of the venom into tissue while sphingomyelinase-D causes necrosis and hemolysis. Sphingomyelinase also triggers an inflammatory reaction in red blood cells resulting in vessel thrombosis, tissue ischemia, and necrosis.[12]

CLINICAL MANIFESTATIONS

Loxoscelism will present as an ulcerative lesion, sometimes not until days after the initial envenomation. In general, within several hours after the initial bite there will be local ischemia resulting in pain, pruritus and swelling. A blister or a central area of purple discoloration will form. The venom causes vasoconstriction and can result in a pale border around the central ulcer/blister/discoloration. Over the next several days the ulcer enlarges and the borders demarcate until 1-2 weeks after the initial bite.[13]

In some cases, systemic loxoscelism can occur. The extent of the cutaneous reaction does not predict the development of systemic loxoscelism, which typically occurs 24 to 72 hours after the envenomation. Young pediatric patients are at greatest risk of reaction. Systemic loxoscelism manifestations include fever, weakness, vomiting, joint pain, petechiae, rhabdomyolysis, disseminated intravascular coagulation, and hemolysis. While rare, severe cases can result in hemoglobinemia, hemoglobinuria, kidney failure, and death.[14]

TREATMENT

Laboratory testing is not indicated for non-necrotizing local symptoms. Treatment of local symptoms includes wound care, tetanus prophylaxis, analgesics, and antipruritics as necessary. There is no antivenom available. Early excision, intralesional injection of corticosteroids, and dapsone are not indicated. The wound may be confused with a localized abscess, and diagnosis may be made following ineffective incision and drainage or antibiotic treatment. Corrective surgery can be performed after the wound has completed progression and has begun to heal, typically several weeks after the envenomation. Prophylactic antibiotics are not indicated, but should be used as appropriate if a secondary bacterial infection develops.[15]

Patients with an expanding necrotic lesion or symptoms of systemic loxoscelism should be admitted to a medical facility. A complete blood cell count, urinalysis for blood, metabolic panel, liver function and coagulation studies should be performed. In those patients who develop hemoglobinuria, increased IV fluid hydration can be used to attempt to prevent acute renal failure. Treat significant hemolysis with transfusions, including exchange transfusion in infants and young children with severe systemic loxoscelism.[16]

TARANTULAS

BACKGROUND/CLINICAL MANIFESTATIONS

There are more than 1500 species of tarantulas found throughout tropical and subtropical areas of the world. While tarantulas are often feared due to their large size and painful bite, their bite is not dangerous to humans. Some indigenous American tarantula species have barbed hairs with which they can strike their victims or they can generate a cloud of hairs (as a defense mechanism) by scratching their abdomen with their legs. These hairs can cause irritation and pruritus of the skin, eyes, and respiratory tract.[17]

TREATMENT

Tarantula bite treatment is supportive and includes cool compresses, analgesics, antipruritics, and tetanus prophylaxis as indicated. Adhesive tape can be used to remove barbed hairs from the skin. If hairs get in the eye, then irrigate copiously. If irrigation is ineffective, then removal by an ophthalmologic surgeon may be necessary. Skin irritation can be treated with topical and oral antihistamines and corticosteroids.[17]

FUNNEL WEB SPIDERS (*ATRAX*)

BACKGROUND

Australian funnel web spiders are capable of inducing a severe and potentially fatal neurotoxic envenomation syndrome. Unlike other species of the spiders, funnel web spiders can bite tenaciously and may have to be physically removed from the victim. They prefer to live on the ground in moist, temperate environments such as burrows, crevices between rocks, and near the foundations of homes. They are named for the tubular or funnel-shaped web they build.[18]

PATHOPHYSIOLOGY

The lethal component of funnel web spider venom is robustotoxin. It induces an autonomic storm by causing excessive release of acetylcholine, norepinephrine, and epinephrine.[19,20]

CLINICAL MANIFESTATIONS

Funnel web spider envenomation causes a biphasic envenomation syndrome. The first phase includes pain at the bite site, perioral tingling, piloerection, and regional fasciculations which may progress to muscle spasm. This muscle spasm may involve the face, tongue, and larynx leading to airway compromise. The increased stimulation of cholinergic and adrenergic systems causes nausea, vomiting, lacrimation, salivation, tachycardia, hypertension, cardiac dysrhythmias, and acute lung injury. Acute lung injury is the predominate cause of death during the first phase.[20]

In the second phase the symptoms of the first phase resolve and lead to the gradual onset of refractory hypotension, apnea, and cardiac arrest.[20]

TREATMENT

Prehospital management consists of pressure immobilization using an elastic crepe bandage applied tightly enough to limit lymphatic spread, but not to restrict blood flow. The venom of the funnel web spider is one of the few animal venoms to undergo local inactivation. The patient should be transported to the nearest medical facility with the bandage in place, and the bandage should not be removed until antivenom is readily available to be administered.[21]

An effective funnel web spider antivenom is available in Australia. An initial dose of 2 vials is indicated for patients with signs of envenomation, while a dose of 4 vials is indicated for pulmonary edema or decreased mental status. The initial dose is repeated every 15 minutes until the patient clinically improves. A dose of 8 vials is commonly reported in cases of severe envenomation.[21]

SCORPIONS

BACKGROUND

Scorpions envenomate humans by stinging them with the telson on their tail. The majority of medically significant envenomations occur in the Middle East, tropics (e.g., Southwest Asia, India, Central and South America), and North Africa. Scorpions are nocturnal, hibernate in the winter, and are active in the warm seasons. Humans are frequently envenomated by scorpions hiding in dark, hidden locations such as inside shoes and small crevices.

Given many scorpion envenomations occur in developing nations lacking significant medical infrastructure, data regarding scorpion envenomations and antivenoms are limited. Studies have estimated over 1.2 million scorpion envenomations per year globally with an overall fatality rate ranging from 0.27% to 0.52%.[22,23] The majority of severe and fatal envenomations occur in children under the age of ten due to their decreased body mass.

PATHOPHYSIOLOGY

Scorpion venoms are complex and can include phospholipase, acetylcholinesterase, hyaluronidase, serotonin, and neurotoxins. Scorpion venom increases neuronal release by blocking inactivation of the sodium channel, resulting in an increase in the amplitude and duration of neuron action potential. The overall result is excess stimulation of the central nervous system, the neuromuscular system, the sympathetic nervous system, and the parasympathetic nervous system.[24]

The components of scorpion venom are species specific and generally fall into the categories of neurotoxic and cardiotoxic; however, this terminology is misleading since the cardiotoxic effects are secondary to an excess release of catecholamines stimulated by the nervous system.[25]

The venom of one unique species of scorpion, *Hemicorpius lepturus*, found in Iraq and Iran is predominately cytotoxic, similar to the brown recluse spider.[26]

CLINICAL MANIFESTATIONS

Scorpion stings produce a painful local reaction often including the sensation of tingling or burning. Erythema at the injection site is common, and discoloration and necrosis sometimes occur.

Symptoms of excess sympathetic nervous system stimulation predominate over symptoms of parasympathetic nervous system stimulation. Sympathetic stimulation via excess catecholamine release produces hypertension, tachycardia, irritability, and agitation. In severe cases, patients may develop seizures and hyperthermia. Excess cardiovascular stimulation may result in myocardial ischemia, myocardial infarction, and cardiac dysrhythmia. In rare cases, severe outcomes occur like bradycardia and hypotension due to excess parasympathetic stimulation, or cardiovascular collapse resulting from catecholamine depletion.[27]

Clinical manifestations of the parasympathetic stimulation include salivation, nausea, vomiting, abdominal pain, pancreatitis, and priapism.[27]

Neuromuscular symptoms include tongue fasciculations, muscle spasms, dysphagia, and dysphonia. Roving eye movements is a classic finding of severe centruroides envenomation (the only clinically significant venomous scorpion indigenous to the United States). While infrequent, severe muscle spasm can result in airway compromise and respiratory arrest.[24]

Pulmonary edema commonly occurs in severe and fatal cases.[25] The pulmonary edema is both cardiogenic and non-cardiogenic in nature. The cardiogenic component is due to reduced cardiac output resulting from excessive sympathetic stimulation. The non-cardiogenic component is due to increased vascular permeability and release of vasoactive substances.

Hemiscorpius lepturus envenomations can cause local skin necrosis and in severe cases hemolysis, disseminated intravascular coagulation, and renal failure.[28]

TREATMENT

The diagnosis of scorpion envenomation is made clinically based on history, symptoms, and signs of envenomation. While older children and adults will almost universally report the initial painful sting, in nonverbal children the diagnosis may be more challenging. Laboratory analysis may reveal an elevated white blood cell count, serum glucose, lactate dehydrogenase, and amylase; however, these tests lack sufficient sensitivity or specificity to be clinically relevant. In those patients with moderate to severe symptoms, an electrocardiogram should be performed to evaluate for evidence of cardiac ischemia or dysrhythmias. A serum troponin may be measured to evaluate for cardiac ischemia.[29] If the envenomation occurred in Iraq or Iran and *Hemiscorpius lepturus* envenomation is suspected, a platelet count, prothrombin time, D-dimer, and fibrinogen level, blood urea nitrogen, and creatinine can be performed to evaluate for evidence of disseminated intravascular coagulation or renal failure.[30]

The majority of scorpion envenomations can be adequately managed with pain medications (ibuprofen, acetaminophen, and opioids) and routine wound management to include tetanus prophylaxis. Most patients, especially adults, will not develop significant symptoms. Patients should be observed for 4-6 hours after envenomation to ensure no delayed onset of symptoms. Prophylactic antibiotics are not indicated. Application of a tourniquet, cauterization, and incision and drainage are contraindicated in scorpion stings. Benzodiazepines may be used to treat significant agitation (which may cause hypertension) or seizures. Pharmacologic management of hypertension is generally not indicated. Intravenous vasopressors such as nitroprusside, nitroglycerin, labetalol, and phentolamine should be used in patients with severe or symptomatic hypertension refractory to benzodiazepines.[31]

For clinically significant envenomation, management is supportive and focused on the patient's symptoms. Benzodiazepines are the first line therapy for sympathomimetic toxicity.[31] Note that benzodiazepines under dosing for sympathomimetic toxicity and seizures is not uncommon. Administer Benzodiazepines aggressively to ensure symptom control. Intravenous propofol or phenobarbital in combination with endotracheal intubation may be used in severe cases. Other anticonvulsants such as phenytoin, levetiracetam, and valproic acid are generally not indicated since they do not treat the underlying sympathomimetic or anticholinergic toxidrome causing the seizures. Direct acting vasopressors (epinephrine and norepinephrine) are recommended to treat bradycardia and hypotension.

In patients with significant neuromuscular spasm, oral secretions, sedation, or other threats to the patent airway, perform endotracheal intubation to prevent aspiration and ensure adequate ventilation. Pulmonary edema should be managed with noninvasive or invasive ventilation in combination with optimization of cardiac output.[31]

The incidence of long-term sequelae resulting from scorpion envenomation is unknown; however, due to the potentially significant risk, priapism should be managed aggressively with antivenom (if available) and other standard treatments of priapism (aspiration and intracavernous injection of phenylephrine) with urology consultation.[32]

Antivenom is available for some species; data regarding the benefits and risks of many of these antivenoms are significantly limited. In patients with moderate to severe symptoms refractory to analgesics and

benzodiazepines, antivenom, if available, may be indicated. Due to the high risk of immediate or delayed allergic reactions to these antivenoms, intravenous histamine antagonists (i.e. diphenhydramine), steroids, and epinephrine should be immediately available at the patient's bedside prior to antivenom administration.

Appendix B provides scorpion sting clinical grading and treatment guidelines. Appendix C provides a list of scorpion antivenoms available by country and their dosing regimens. Several studies demonstrate improved efficacy of intravenous compared to intramuscular antivenom administration.[33] Antivenom dosing does not depend on patient weight or size and is the same for adult and pediatric patients.[34]

ADVERSE REACTIONS TO ANTIVENOM

Antivenoms have the potential to cause immediate and potentially life-threating, anaphylactoid reactions. Reactions can range from mild (pruritus, rash) to severe (wheezing, hypotension, respiratory distress, cardiovascular collapse, and death). Antivenoms may also cause serum sickness. Serum sickness is a type III hypersensitivity reaction which is characterized by flu-like symptoms with or without a rash that typically occurs between 2 days and 3 weeks after antivenom administration. Serum sickness is uncomfortable but not life threatening.[35]

ADVERSE REACTION MANAGEMENT

Unfortunately, data on the incidence of adverse reactions to antivenoms used outside of developed nations are lacking. Medical providers should anticipate a high likelihood for serious and potentially life-threatening anaphylactoid reactions to antivenoms not approved by the US Food and Drug Administration (FDA). For this reason, antivenom should only be used in patients with moderate to severe symptoms refractory to standard medical therapies (e.g., benzodiazepines and pain medications). Epinephrine should be immediately available at the patient's bedside prior to the administration of antivenom to ensure rapid administration if necessary.

For mild to moderate symptoms occurring during antivenom infusion (e.g., nausea, vomiting, urticaria, pruritus, chills, fever), stop the infusion immediately and treat symptoms with antiemetics, antihistamines (typically diphenhydramine), and steroids (i.e. methylprednisolone, prednisone, prednisolone). If the reaction is controlled after treatment and the patient's condition still requires antivenom, restart the antivenom at a slower infusion rate.

For severe reactions (i.e. respiratory distress, hypotension), immediately stop the antivenom infusion and treat using a standard anaphylaxis protocol (diphenhydramine 50 mg [1 mg/kg in pediatric patients] IV, methylprednisolone 125 mg [2 mg/kg in pediatric patients] IV, and 0.3 mg [0.15 mg in pediatric patients] of 1:1000 epinephrine intramuscularly).[36-39] Consider adding an H2 antihistamine such as famotidine. If necessary, intubate for airway edema not rapidly responsive to epinephrine. If antivenom is considered necessary to prevent death or disability, the antivenom may be reinitiated at a slower rate of infusion in conjunction with an epinephrine infusion.

In patients who develop serum sickness, management consists of symptomatic treatment with antihistamines and pain medications with or without a course of oral steroids.[35]

PERFORMANCE IMPROVEMENT (PI) MONITORING

INTENT (EXPECTED OUTCOMES)

- Rapid evaluation and transfer to site with antivenom capability for envenomation
- Tetanus prophylaxis when appropriate

PERFORMANCE/ADHERENCE MEASURES

- Transfer of patients with moderate to severe symptoms (grades 3 and 4) to antivenom if not available at site
- Aggressive use of benzodiazepines as indicated for agitation, neuromuscular stimulation, tachycardia, and hypertension
- Tetanus prophylaxis for all bites and stings

DATA SOURCE

- Patient record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually. Additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief, JTS Program Manager and the JTS PI Branch.

RESPONSIBILITIES

It is the clinical team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: LOCATION OF CLINICALLY SIGNIFICANT VENOMOUS SPIDER SPECIES

Geographical Location of Clinically Significant Venomous Spider Species			
Continent	**Latrodectus (i.e. Black Widow)**	**Loxosceles (i.e. Brown Recluse)**	**Funnel Web**
Africa	X	X	
Asia	X	X	
Australia	X	X	X
Europe	X		
North America	X	X	
South America	X	X	

APPENDIX B: CLINICAL GRADE AND TREATMENT OF SCORPION STINGS

Clinical Grade and Treatment of Scorpion Stings		
Grade	**Effects**	**Treatment**
1	Local effects only	Analgesia, tetanus prophylaxis
2	Mild/Moderate autonomic excitation (i.e. tachycardia, hypertension)	Benzodiazepines, cautious use of beta-antagonists and vasodilators
	Agitation and anxiety	Benzodiazepines
	Pain and paresthesias remote from the sting site	Analgesia
3	Pulmonary edema	Antivenom, noninvasive or mechanical ventilation
	Hypotension and cardiogenic shock	Antivenom, vasopressors (i.e., norepinephrine, epinephrine)
	Neuromuscular excitation, somatic neuromuscular dysfunction **or** cranial nerve dysfunction (associated with *Centruroides* species)	Antivenom, benzodiazepines
4	Multiorgan failure, coma, seizures, end-organ damage secondary to hypotension, somatic neuromuscular dysfunction **and** cranial nerve dysfunction (associated with *Centruroides* species)	Antivenom, vasopressors, sedation (benzodiazepine, propofol, phenobarbital), mechanical ventilation

Modified from Isbister and Bawaskar.[39]

APPENDIX C: SCORPION ANTIVENOMS AVAILABLE IN EACH COUNTRY

Antivenoms Available in Each Country			
Country	**Species the antivenom treats**	**Antivenom**	**Antivenom dosing regimen**
Morocco	*Androctonus australis garzonii, B. occitanus tunetanus, Tityus serrulatus*	Polyvalent scorpion antivenom	2-10 mL IV
Egypt	*Leiurus quinquestraitus, Androctonus amoreuxi, Androctonus crassicauda, Androctonus aeneas, Androctonus australis, Scorpio marus palmatus, Buthus occitanus*	Purified polyvalent anti-scorpion serum (equine)	5 1-mL ampules IV
Algeria	*Androctonus australis*	Scorpion antivenom (Pasteur Institute of Algeria)	10 mL IV Note: one study showed no benefit with this dose.
Mexico, United States	*Centruroides limpidus, C. noxius, C. suffuses, C. exilicauda*	Polyvalent scorpion antivenom	3 vials, each reconstituted in 5 mL of sterile normal saline (NS). Combine all 3 reconstituted vials in 50 mL NS infused IV over 10 minutes
Brazil	*Tityus serrulatus*	Soro antiescorpionico	20 mL IV
South Africa	*Parabuthus spp.*	Monovalent scorpion antivenom	5-10 mL IV
India	*Hottentotta/Mesobuthus tamulus*	Monovalent red scorpion antivenom	2-8 vials, each diluted into 10 mL of distilled water and administered IV over 5-7 minutes
Tunisia	*A. australis, B. occitanus*	Bivalent scorpion antivenom (Institut Pasteur, Tunis, Tunisia)	20 mL IV; however, one study showed no benefit
Saudi Arabia	*Leiurus quinquestriatus, Androctonus crassicauda, Buthus arenicola, Buthus mimax, Buthus occitanus, Leiurus quinquestriatus hebreus, A. amoreuxi*	Polyvalent scorpion antivenom	Manufacturer recommends 1 ampule, repeated until symptoms controlled. One study found a typical effective dose to be 5 to 20 1-mL ampules IV
Israel	*Leiurus quinquestriatus*	Monovalent scorpion antivenom	5 to 15 mL of antivenom diluted in 5% dextrose and 33% sodium chloride administered IV
Argentina	*Tityus trivittatus*	Scorpion antivenom	See package instructions.
Venezuela	*Tityus zulianus*	Scorpion antivenom	See package instructions.

Modified from Bahloul et al.[25]

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including an appropriate information sheet for distribution to patients within an appendix, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

High Bilateral Amputations and Dismounted Complex Blast Injury (CPG ID: 22)

To review indications for and the procedures associated with the initial management of bilateral lower extremity amputations with associated pelvic/perineal injuries.

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BACKGROUND

The Dismounted Complex Blast Injury (DCBI) injury pattern consists of (generally proximal) bilateral lower extremity amputations with associated pelvic/perineal injuries and frequently also includes upper extremity injuries (which may be bilateral but most commonly involve the left side due to weapon carrying stance at the time of injury) as well as frequent thoracoabdominal or neuraxial injuries. DCBIs represent one of the most challenging cohorts of surgical patients from management of the initial injury through definitive reconstruction. These injuries are associated with a high incidence of both morbidity and mortality. Survival is initially dependent upon hemorrhage control and massive transfusion and resuscitation protocols. A coordinated team approach is essential to provide simultaneous airway management, volume resuscitation (ideally with Whole Blood (WB) or ratio transfusion), and immediate control of life threatening hemorrhage.[1]

Later risks for mortality include sepsis and multisystem organ dysfunction. These injuries can broadly be divided into two categories; those with a perineal/pelvic floor injury and those without. Counterparts or similar injuries in civilian trauma remain rare. An organized aggressive continuum of care from the Point of Injury (POI) onwards by medics, anesthetists, general and orthopaedic surgeons and intensivists is critical to optimize outcomes.

EVALUATION AND TREATMENT

INITIAL RESUSCITATION

These patients typically arrive in extremis shortly after injury. Tourniquets are often in place on all injured extremities. Due to profound shock and associated upper extremity amputations, IV access may not be obtained in the field. Rapid placement of Intra-Osseous (IO) lines is sometimes a useful adjunct to begin resuscitation prior to venous access. Large bore central venous access should be considered early and placed by an experienced proceduralist. This injury pattern mandates immediate activation of massive transfusion protocols, the preferential use of fresh packed red blood cells (< 21 days old), minimal use of crystalloid products, and early consideration for the use of WB, if blood resources are limited. Refer to the Damage Control Resuscitation (DCR) and WB Transfusion CPG for specific recommendations.[2,3]

ROLE OF RESUSCITATIVE THORACOTOMY

Occasionally these patients arrive with CPR in progress. When signs of life are present, consideration of resuscitative thoracotomy should be given according to established CPGs. Outcome data from OIF suggest a reasonable survival rate in properly selected patients.[4,5] Another alternative described with exsanguination in civilian extremity injuries is the use of a brief period of CPR with concomitant massive blood product resuscitation before resorting to a resuscitative thoracotomy. A review of the Department of Defense Trauma Registry (DoDTR) in 2011, suggests the mortality associated with bilateral high amputations, pelvic injury and emergency department thoracotomy is very high (>90%). Experienced military surgeons debate the optimal approach to prevent ongoing hemorrhage in this population – thoracic, distal aortic or bilateral iliac proximal vascular control. Endovascular aortic balloon occlusion may offer an elegant alternative for proximal vascular control in the future.[6]

TRIAGE CONSIDERATIONS

These patients can consume massive amounts of blood products and utilize multiple surgical assets to include operative teams, equipment and operative hours. In multiple casualty scenarios, a prudent assessment of resource allocation should be done prior to proceeding with resuscitative thoracotomy.

PREOPERATIVE STUDIES

Useful preoperative studies may include chest radiograph, anterior-posterior pelvic radiograph, Point-of-Care Ultrasound and Diagnostic Peritoneal Lavage, but should not delay surgical control of hemorrhage. Expeditious computed tomography of the head may be considered in patients displaying lateralizing signs consistent with severe traumatic brain injury requiring operative intervention, but should not degrade resuscitation or delay surgical hemorrhage control.

OPERATIVE APPROACH

PRIORITIZATION AND SURGICAL TEAMS

The initial operative goal is hemorrhage control and control of contamination. Due to the nature of these injuries, this is best achieved using a team of general and orthopaedic surgeons working concurrently on the patient, when possible. For example, two surgeons can achieve proximal control and address intra-abdominal injuries while a second team focuses on the amputations. A third team can be utilized to address upper extremity injuries, if present. This approach maximizes efficiency and limits prolonged physiologic insult to a severely injured patient. Prior to operation, the most critical procedures (e.g. proximal hemorrhage control, control of contamination, completion amputations, bladder repair and potential colonic diversion) should be listed, keeping in mind reasonable parameters to terminate surgery.

PROXIMAL VASCULAR CONTROL

The level of proximal vascular control is dictated by several clinical variables: previous resuscitative thoracotomy, associated pelvic disruption, level of tourniquet placement and level of amputation(s). Typically vascular control should be achieved at the most distal level possible, including control via a retroperitoneal approach or in the groin. A strategy of walking the clamps down in patients with massive pelvic injuries is prudent. This involves laparotomy, infra-renal aortic control, and movement of control distal to the internal and external iliacs.[7] In the case of pelvic floor injuries with open pelvic wounds and active posterior bleeding, temporary control of the internal iliacs is prudent. This can be achieved with vascular clamps, vessel loops, Rummel tourniquets, or vascular clips. The benefit of achieving hemorrhage control must be balanced against the risk of ischemic tissue at the site of injury and subsequent infection and diminished wound healing. An attempt to reperfuse the internal iliacs should be made at the index or subsequent procedure. Ligation of both internal iliac arteries is to be avoided if at all possible; in cases of ongoing pelvic hemorrhage despite pelvic packing and angiographic embolization if available, bilateral internal artery ligation may be necessary although significant tissue necrosis (e.g., buttocks) can be anticipated.

ROLE OF PROXIMAL DIVERSION

In patients with an obvious need to divert the fecal stream due to pelvic disruption or an open pelvic fracture, stapled interruption of the sigmoid colon at the pelvic brim should be performed early to facilitate pelvic exposure and vascular control. Formal colostomy should be delayed until subsequent operative procedures when the patient is more stable.

ORTHOPEDIC CONSIDERATIONS

It is common for these patients to present with traumatic bilateral lower extremity amputations at various levels from transtibial amputations to very high transfemoral amputation's, often with extremely complex soft tissue blast wounds up to and including the perineal and gluteal region. (See Figure 1 on next page.) Associated traumatic amputation of the non-dominant upper extremity is also common. The most challenging cases involve open pelvic ring and peri-acetabular fractures (Figure 2 next page) and dislocations associated with severe perineal injuries. Initial orthopaedic resuscitative involvement entails assuring that extremity hemorrhage control is sufficient with tourniquets. After the initiation of volume resuscitation, patients can often bleed

through in-place field tourniquets; in this case, they require placement of additional field tourniquets or pneumatic ones (if available) to control bleeding until optimized in the operating theater. Quick examination of the pelvic ring should be performed to address stability. Pelvic fractures can be stabilized with the use of clamped sheets or commercial pelvic binders centered over the trochanters.

Figure 1. Dismounted Complex Blast Injuries

Figure 2. Open Pelvic Ring and Acetabular Fractures

Figure 3. Same Patient After Pelvic External Fixation

Index operative procedures should be prioritized with surgical team leader.[8] Hemorrhage control of traumatic amputated limbs and peri-pelvic sources is the priority. Pelvic and perineal packing is helpful for tiny vessel hemorrhage control and cases with continued oozing due to coagulopathies. In the multilevel amputee, limb length is inversely proportional to later energy expenditure. Revision or completion amputations should occur at the most distal viable level with double ligation of all named vessels in an open, length-preserving fashion. Atypical rotational flaps are greatly preferred over guillotine-style or open circular amputations. Care should be given to salvaging healthy tissue for flap coverage, even if it is an atypical rotational flap in the face of destroyed or missing conventional flap tissue. When necessary, maintained pelvic ring stabilization with external fixation (Figure 3 above) is preferable to prolonged use of binders due to proximity of wounds and serial debridements that will be required. Anterior superior iliac spine/iliac crest or anterior inferior iliac spine pins are both appropriate, with the latter offering the greatest reduction control but requires available fluoroscopy and surgeon experience. Consideration should be given for later reconstructive orthopaedic pelvic incisions so as to appropriately divert the location of colonic and urinary streams. External fixation of long bone fractures should be accomplished during the index procedure, when possible. Smaller bone and joint fractures can be addressed if the patient remains stable, otherwise they are cared for after the initial operative resuscitation, such as splinting in the intensive care unit or during subsequent surgical procedures.

SOFT TISSUE DEBRIDEMENT

(See Management of War Wounds CPG[5])

Adequate initial surgical debridement is critically important. DCBI wounds are typically complex and extensive. They may be grossly contaminated with dirt, fragment debris, clothing and foliage. Wounds should be incised with well-planned incisions extending from the primary zone of injury to healthy tissue. Systematic debridement of nonviable skin, subcutaneous tissue, fascia, muscle, periosteum and bone is critical to reduce the bioburden and later risk of sepsis.[9,10] Blast wounds tend to evolve; if tissue is questionable and not contaminated it should be maintained and addressed at later surgical interventions. However, since the timing of the next operation (often at the next echelon of care) is unpredictable, avoid leaving marginally viable tissue behind as many of these complex wounds will develop progressive necrosis. When present, pelvic/perineal and pelvic wounds need to be similarly addressed.

ASSOCIATED VASCULAR INJURIES

DCBI injury pattern appears to be associated with iliac vein injury. When possible these injuries should be shunted or repaired rather than ligated. Unless easily repairable, arterial injuries in these critically injured patients should be managed initially with shunting followed by formal repair at subsequent operation. Care should be taken to avoid exclusion of the profunda femoris during shunting or repair, in order to perfuse the soft tissue and muscle.[11]

ASSOCIATED GU INJURIES

Associated injuries to the ureters, urethra, bladder, scrotum, penis, and prostate are common. These should be addressed if feasible with a focus on hemorrhage control, urinary control or diversion, and preservation of tissue for later reconstruction. See *JTS Urologic Trauma Management* CPG for specific recommendations.[9]

ASSOCIATED (OCCULT) RECTAL INJURIES

Computerized Tomography (CT) alone may not always accurately exclude penetrating distal rectal injury in the setting of multiple perineal or perirectal fragmentation wounds with scatter artifact and random trajectories. Therefore, fragmentation wounds to the perineum and perianal regions should generally prompt proctoscopic examination of the rectum even if digital rectal examination in the emergency room is negative for blood. This may be difficult in the supine position and may be readily completed in the supported lateral position. Completion of the proctoscopic exam should be done prior to completing laparotomy as colonic diversion may be indicated even if there is no other strict indication based on the proximity of blast wounds to the fecal

stream. If clot or active bleeding is identified on proctoscopic examination, the distal sigmoid colon/proximal rectum should be divided and later matured at a subsequent operation into an end colostomy once the patient is stabilized further along the evacuation chain.

Distal rectal wash out is not always necessary unless there is bulky retained stool in the presence of a suspected penetrating injury.

CONSIDERATION OF PRONE POSITIONING

In most patients, the posterior soft tissue injuries can be addressed with elevation of the amputated stumps or with the patient in a lateral position after the supine portion of the case has been completed. However, certain injury patterns have a large posterior element. In these cases it is sometimes necessary to prone the patient during the index procedure after hemorrhage control, for debridement of deep blast wounds in the gluteal and low back region. This decision should not be made lightly due to the time requirements and risks involved and can often be deferred to secondary procedures. When undertaken, the use of a Jackson table can facilitate a safe transition to the prone position. Unstable pelvic ring injuries should be stabilized prior to proning a patient as this position can exacerbate pelvic volume widening and resulting hemorrhage. Alternatively, lateral positioning with a bean bag may be considered.

TEMPORARY ABDOMINAL CLOSURE

Liberal use of temporary abdominal closure with delayed stoma maturation is advised.

WOUND DRESSINGS

Traumatic wounds should not be definitively closed until multiple adequate debridements have been performed and serial wound stability and maturation demonstrated. By nature, the extensive soft tissue destruction and degree of contamination in these wounds make them infected until proven otherwise, and a series of surgical debridements is necessary to prepare wounds for closure or coverage. If necessary and in the face of clean viable tissue, incisions made to extend the zone of wounds to healthy levels can be loosely approximated to prevent massive skin retraction. The preferred initial wound dressings include moist-to-dry, Dakin's soaked gauze, antibiotic bead pouches or negative pressure wound therapy with reticulated open cell foam or moist gauze.

PERIOPERATIVE MANAGEMENT

NEED FOR RADIOLOGIC IMAGING

These injuries are associated with a significant transfer of energy to the casualty, resulting in high risk for associated injuries of a blunt and penetrating nature. Once the patient is physiologically stabilized, complete imaging including "Pan Scan" CT and plain film examination should be obtained to evaluate for occult injury.[2]

NEED FOR REPEATED DEBRIDEMENTS

The treatment team must appreciate the phenomenon of wound evolution and the high risk for invasive fungal infection and expect that viability of the soft tissues will fluctuate over the course of several days. In the acute phase (<72 hours from injury) wounds should be frequently inspected in the operation room (e.g. every 24 hours). In the later, sub-acute phase (3-7 days from injury) wounds may require less frequent treatment based on the presence of viable tissue and absence of ongoing necrosis or persistent contamination. Multiple debridements are routinely required and the massively injured, physiologically deranged patient should not undergo excessive surgical procedures during the initial operation other than those required to control hemorrhage and gross contamination. See the JTS *Initial Management of War Wounds* and *Invasive Fungal Infection* CPGs on the JTS CPG website for further guidance.[10,12]

ROLE OF SYSTEMIC AND TOPICAL ANTIBIOTICS

Initial antibiotic selection should avoid empiric broad spectrum coverage but rather focus on narrow spectrum antibiotics, such as first generation cephalosporins, and the liberal use of topical delivery with Dakin's soaked gauze or antibiotic beads. See *JTS Infection Prevention in Combat-Related Injuries CPG* for specific recommendations.[13]

ROLE OF VTE PROPHYLAXIS

DCBI patients are at very high risk of developing proximal deep vein thrombosis (DVT) and associated pulmonary embolus (PE). The presence of lower extremity amputation does NOT reduce this risk. In fact, patients with lower extremity amputations may actually be at higher risk for development of DVT and PE than those with similar injury severity without lower extremity traumatic amputation. It is recommended that these patients be started on appropriate DVT/PE prophylaxis as soon as coagulopathy is reversed. If contraindications to prophylactic anticoagulation persist, prophylactic IVC filter placement should be strongly considered. See *JTS Prevention of Venous Thromboembolism – Inferior Vena Filter CPG* for further recommendations.[14]

TRANSFER OF CARE

The down-range surgeons should make every effort to coordinate dressing changes and necessary repeat debridements in anticipation of required patient transport up-range. Given the propensity for wounds to evolve in their acute phase, the down-range surgeons must maintain a low threshold to perform additional debridement prior to evacuating the casualty if the patient would otherwise require an unacceptable interval between debridements. Given the unpredictable nature of the air evacuation system and to optimize timing of subsequent serial debridements, the patient should remain NPO for flight so that they are prepared for the next operation.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All combat casualties with bilateral lower extremity amputations, at least one above the knee, with mechanism of injury explosive/IED or landmine, dismounted.

INTENT (EXPECTED OUTCOMES)

1. The pelvis is stabilized prehospital or immediately on arrival to the hospital with pelvic binder or junctional tourniquet placement in all patients with bilateral lower extremity amputations.
2. All patients who undergo laparotomy have temporary abdominal closure at first operation (or reason to safely close abdomen is documented).
3. All patients with high bilateral lower extremity injuries have a documented rectal exam, and have a documented proctoscopy if perineal/peri-rectal penetrating wounds are present.
4. When GU injury is present, debridement conserves tissue to the greatest extent possible.
5. All patients with dismounted complex blast injury have a second debridement performed within 24 hours of the initial debridement.
6. All patients have VTE prophylaxis started within 24 hours (or documented reason why contraindicated).

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have the pelvis stabilized prehospital or immediately on arrival to the hospital with pelvic binder or junctional tourniquet placement.

2. Number and percentage of patients in the population of interest who undergo laparotomy and the number who have temporary abdominal closure at first operation (or reason to safely close abdomen documented).

3. Number and percentage of patients in the population of interest who have documented rectal exam.

4. Number and percentage of patients in the population of interest who have perineal/peri-rectal penetrating wounds who have a documented proctoscopy.

5. Number and percentage of patients in the population of interest who have injury to external genitalia who have preservation of injured testicle(s) at the initial operation.

6. Number and percentage of patients in the population of interest who have a second debridement performed within 24 hours of the initial debridement.

7. Number and percentage of patients in the population of interest who have VTE prophylaxis started within 24 hours (or documented reason why contraindicated).

8. Number and percentage of patients in the population who survive evacuation from first MTF and the number who survive to final discharge from role 3/role 4.

DATA SOURCE

- Patient Record
- DoD Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Hyperkalemia and Dialysis in the Deployed Setting (CPG ID: 52)

Provides recommendations for the management of patients with, or at risk for, acute kidney injury and hyperkalemia in the deployed environment.

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SUMMARY OF CHANGES

1. Medical management for hyperkalemia flow chart and table.
2. Increase in treatment threshold to a K of 6.0 from 5.5 in tracking metrics.
3. Continuous Renal Replacement Therapy (CRRT) modality change from Continuous Venovenous Hemofiltration (CVVH) to Continuous Venovenous Hemodialysis (CVVHD).
4. CCRT flow chart.
5. Drug dosing recommendations for CVVHD.
6. Anticoagulation recommendation for CVVHD.
7. Recommendation for nutrition.
8. Addition of oral potassium binders.
9. Removed use of sodium bicarbonate for hyperkalemia.
10. Improvised dialysate fluid for CRRT and peritoneal dialysis.
11. Assessing fluid status recommendations.

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BACKGROUND

Acute kidney injury (AKI) is a recognized complication of combat trauma. According to the Department of Defense Trauma Registry (DoDTR) data, AKI was listed as a complication in 0.6% of combat casualties. This is likely an under-representation of the real incidence as it was required to be listed as a complication in the available documentation. Smaller studies from two Role three facilities in theatre show AKI after combat trauma occurs in up to 34.3% of the most critically injured patients, usually within the first two days after injury.[1] This is likely closer to the real incidence in severely injured patients as a more thorough definition of AKI was used and is described below. Review of the DoDTR data did capture the number of patients that required renal replacement therapy (RRT) either in the form of continuous venovenous replacement (CRRT) or peritoneal dialysis (PD). Of the 558 patients with AKI listed as a complication, 112 or 20% required renal replacement. Of these 112 patients, 35 or 31% required RRT while still in theatre. In the recent conflicts in Iraq and Afghanistan, rapid evacuation out of theater ensured that the complications of AKI (including hyperkalemia) occurred further up the evacuation chain (Role 3-4), where RRT may have been available;[2] Furthermore, rapid damage control resuscitation and surgery likely decreased the rate of severe AKI. As a consequence, there are no recent data on the frequency of hyperkalemia following AKI in theater when experiencing delays in treatments and evacuations. However, evidence from prior conflicts suggests that up to one-third of combat casualties with oliguric renal failure developed severe hyperkalemia within four days of injury.[3] In future operations, military providers should be prepared for prolonged evacuation times.[4] AKI and life threatening hyperkalemia may be encountered at Role 3 facilities more frequently, where RRT is limited or non-existent. This is an important planning factor in future Large Scale Combat Operations (LCSO) where there may be multiple Role 3s and limited availability to move casualties compared to the previous conflict. AKI is classified by relative changes in creatinine and can be diagnosed with as little as a 0.3mg/dL increase in creatinine over a 48 hour (hr) period.[5] AKI can also be determined by decreased urine output (< 0.5 ml/kg/hr for at least 6 hours). While mild AKI can generally be managed with supportive care; more severe AKI [characterized by oliguria (<500 ml/day of urine output and/or <0.5 mL/kg/hr) or a doubling of serum creatinine] may require RRT. Therefore, providers caring for patients in austere or deployed environments should monitor patients for AKI and be prepared to expedite evacuation to a higher echelon of care, when necessary.

RECOMMENDATIONS

These recommendations are intended to temporize patients until they can be evacuated to a higher echelon of care with the full range of RRT capabilities.

ETIOLOGY OF HYPERKALEMIA

Providers in the operational setting should be proactive in correcting hyperkalemia. Rhabdomyolysis, dehydration (especially in the setting of Non-steroidal anti-inflammatory drugs), hypotension, packed red blood cells transfusions, sepsis, and urinary obstruction are a few causes of hyperkalemia encountered in the deployed setting.

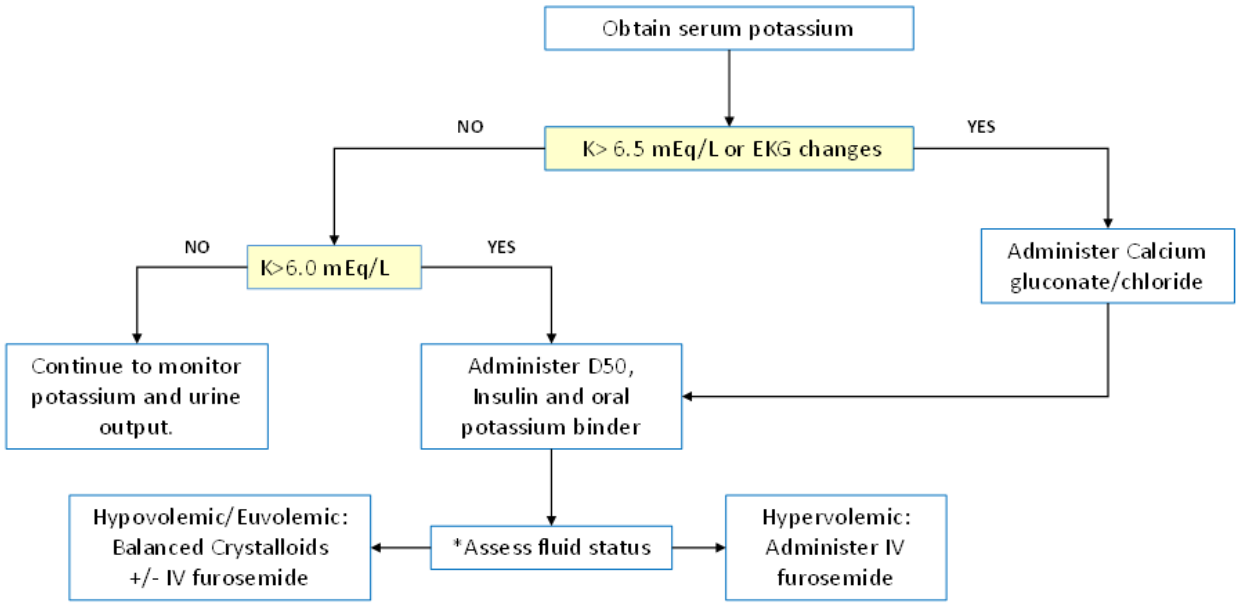
MONITORING

Monitor serum potassium, serum creatinine, hourly urine output, and an electrocardiogram (if available) in patients at risk for AKI and hyperkalemia.

MEDICAL MANAGEMENT

Medical therapy is the first step of AKI management with hyperkalemia. This includes cardiac membrane stabilization (with intravenous calcium chloride or calcium gluconate) and/or shifting potassium intracellularly (with insulin and glucose or a β-2-adrenergic agonist). Consider maneuvers to remove potassium with diuretics and potassium binding agents; usage may be limited by hemodynamic status, anuria, and bowel injuries. We suggest shifting potassium intracellularly when the potassium is greater than 6.0 milliequivalents per liter (meq/L) [with intravenous insulin and 50 percent dextrose (D50), with or without albuterol]. Take into account the clinical situation when determining when to treat hyperkalemia. For example, a rapid rise or impending evacuation should prompt consideration for shifting at a lower cut-off (i.e. 5.5meq/L). Calcium should be given if there is evidence or suspicion of clinically significant hyperkalemia and evidence of altered conduction on electrocardiogram such as: peaked T waves, widened QRS, flattened P waves, bradycardia, ventricular tachycardia, ventricular fibrillation, right and left bundle block, pseudo infarct, and Brugada pattern.[6,7,8] Calcium should also be considered empirically for a potassium concentration >6.5 meq/L. See Appendix A for a list of medications, routes of administration and recommended treatment order. The use of Balanced Crystalloids in the setting of hyperkalemia may seem contraindicated. However, through volume of distribution administering a potassium containing fluid which is lower than the patient's serum potassium will in fact lower the serum potassium concentration.[9] Providing a hyperchloremic crystalloids such as 0.9% normal saline will result in mineral acidosis thus worsening hyperkalemia.[10]

Figure 1. Medical management for hyperkalemia



**see Appendix E on assessing fluid status*

Table 1. Medical management for hyperkalemia

	Access	Monitoring	Therapies	Other Comments
Good	▪ 2 Large Bore IVs	▪ Frequent Clinical Checks ▪ Frequent Vital Signs ▪ Monitor urine output	▪ Calcium ▪ Balanced Crystalloids*	Crystalloids if no contraindication such as uncontrolled hemorrhage
Better	▪ 2 Large Bore IVs ▪ Foley Catheter	▪ Frequent Clinical Checks ▪ 12 lead EKG ▪ Foley to monitor urinary output (UOP) ▪ Glucometer	▪ Calcium ▪ Balanced Crystalloids* ▪ D50/Insulin ▪ Albuterol(neb) ▪ Furosemide	Note that in the absence of potassium monitoring, these would only be considered if characteristic EKG or peri-arrest patient with high clinical suspicion.
Best	▪ 1-2 Large Bore IVs ▪ Central Venous Catheter ▪ Foley Catheter	▪ Frequent Clinical Checks ▪ Continuous EKG Monitoring ▪ 12 lead EKG ▪ Foley to monitor UOP ▪ Glucometer ▪ Point-of-care labs	▪ Calcium ▪ Balanced Crystalloids* ▪ D50/Insulin ▪ Albuterol (neb) ▪ Furosemide ▪ Potassium binder	Use caution with furosemide as this may exacerbate hypotension in acute resuscitative phase. See Figure 1 flow chart.

**Balance Crystalloids= Lactated Ringers or Plasmalyte ®*

FAILURE OF MEDICAL MANAGEMENT

In the experience of the authors, the most common reason for starting RRT for patients with AKI in the deployed setting is hyperkalemia resistance to medical management. A potassium level greater than 6 meq/L, despite medical management, should prompt consideration of RRT with either the NxStage System One or acute PD. Occasionally, patients may require RRT in theater for other indications, such as acidemia or severe volume overload. The following detailed methods can effectively temporize patients with these indications as well.

SEVERE HYPERKALEMIA & NXSTAGE SYSTEM ONE

If available, use the NxStage System One for severe hyperkalemia that does not respond to medical management. To utilize this system, the patient must have central venous access with a dialysis catheter, the machine must be setup and the prescription must be entered. There are five components to a CRRT prescription: mode, blood flow rate, replacement fluid, replacement fluid rate, and ultrafiltration rate. See Appendix C for a suggested initial prescription.

Central Venous Access

Place a hemodialysis catheter, prior to initiation. In terms of location, follow guidelines,[5] which suggests the first choice of access is the right internal jugular vein (with a 12-14 French, 15cm catheter), because this location has been associated with the lowest rates of catheter dysfunction.[11] The second choice is the femoral vein (with a 20-25cm catheter). The last choice is the left internal jugular vein (with a 20cm catheter) because it is associated with the highest rates of catheter dysfunction.[11] If possible, avoid the

subclavian veins. Lines in this location often result in subclavian stenosis, which can complicate or preclude future dialysis access in patients at risk for the development of end stage renal disease.[12,13]

Setup

The Set up – Initiate – Make connections – Program – Launch treatment – End (SIMPLE) instructions are displayed on the NxStage computer screen once the machine is turned on. These instructions are quite detailed and, if followed closely step-by-step, will guide the provider through priming the cartridge, putting the patient on the machine, entering the prescription and ending the treatment once it is complete. Ideally, providers that deploy to a location with the NxStage System One should receive training on the setup and use of the system prior to deployment. The instructions are straightforward enough to allow an inexperienced physician or nurse to perform a treatment within the deployed setting.

Mode

The NxStage System One can provide continuous venovenous hemodialysis (CVVHD), which is the recommended form of CRRT for the down-range setting. Complete this by connecting the two green ports as specified in the step-by-step priming instructions.

Blood Flow Rate

The minimum blood flow rate is 200ml/minutes (min) and should be increased to 400ml/min if possible. A faster blood flow rate will decrease the likelihood of blood clotting the filter. The most common limitation for increasing the blood flow rate is the pressure required to draw blood out of the dialysis catheter. If this pressure becomes too negative, the machine will alarm and stop the treatment. This alarm is often due to catheter port suction against the vessel wall. If this occurs, decrease the blood flow rate until the machine no longer alarms. Catheter manipulation, line reversal, or line relocation may solve this issue. To manipulate the catheter, using the sterile technique, grasp the catheter proximal to the sutured/secured hub and twist it 180 degrees. This may move the blood flow ports away from a vessel wall. To reverse the lines, first stop the machine and clamp both the blood lines and both the dialysis catheter ports. Then disconnect the blood lines and re-connect them to the dialysis catheter ports opposite of how they were previously connected. If these efforts fail, consider an alternate insertion site for the catheter.

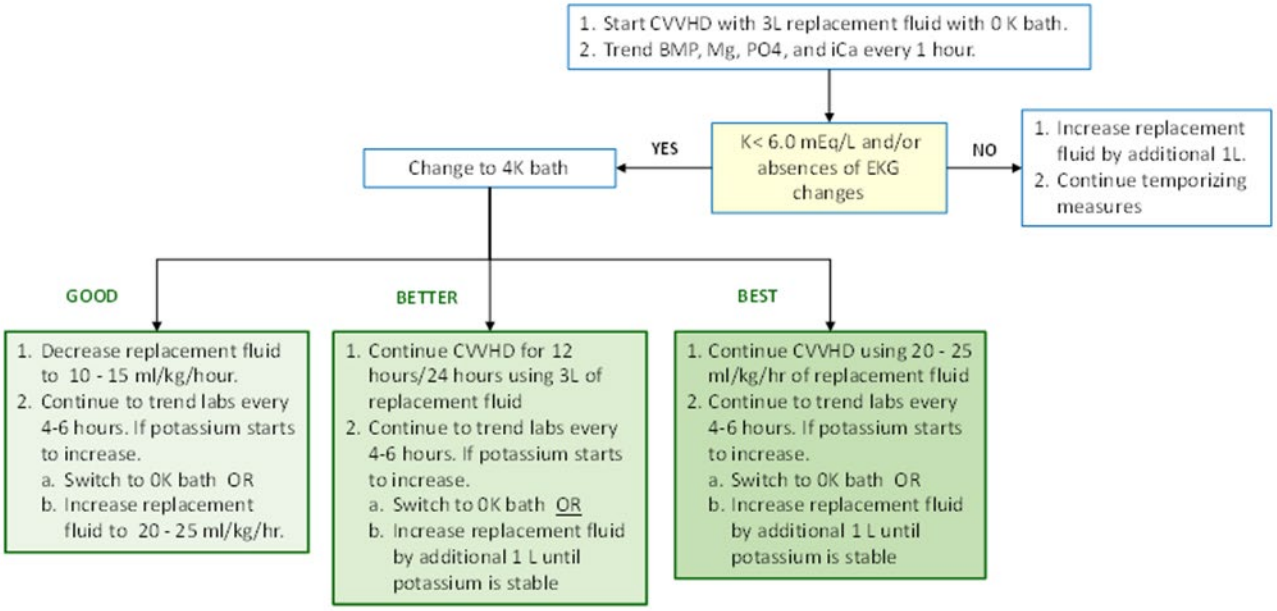
Dialysate Fluid

There are several commercially made replacement fluids. Regardless of the specific brand available, there will be 0meq/L potassium (0K) and 4meq/L potassium (4K) options. Since CRRT in the deployed environment is usually initiated for hyperkalemia, we suggest starting with the 0K fluid and following the potassium concentration every hour. Once the potassium decreases to <6.0 meq/L and/or absences of EKG changes, the patient can be transitioned to the 4K replacement fluid. It is important to note that the replacement fluid bags have two separate compartments, to avoid precipitation of calcium and bicarbonate. It is vital that the seal between the two compartments is broken in the manner detailed in the step-by-step instructions on the NxStage System One display screen. If commercial solutions are not available, replacement fluids can be made (See Appendix E).[14] Despite which fluid is in use, closely monitor ionized calcium, magnesium and phosphate (every 6 hours) if possible and replace as needed.

Dialysate Flow Rate

The dialysate flow rate is the rate at which the machine infuses dialysate fluid and it is the primary determinant of clearance. Initially, we suggest starting with a dialysate flow rate of 3L/ hour with hourly monitoring of serum potassium. If the potassium fails to improve, increase the dialysate flow rate. With the NxStage System One, the maximum dialysate flow rate is dependent on the blood flow rate. If high clearances are needed, increase the blood flow rate to 400ml/min and set the dialysate flow rate as high as the machine allows (8.4L per hour). If this fails, the patient likely has severe ongoing tissue necrosis and you need to consider surgical re-evaluation for debridement. Reduce the dialysate flow rate or consider stopping CVVHD once you have reached a reasonable serum potassium level in order to conserve resources.

Figure 2. CRRT management for hyperkalemia


1. Start CVVHD with 3L replacement fluid with 0 K bath.
2. Trend BMP, Mg, PO4, and iCa every 1 hour.
K< 6.0 mEq/L and/or absences of EKG changes
YES
NO
Change to 4K bath
1. Increase replacement fluid by additional 1L.
2. Continue temporizing measures
GOOD
BETTER
BEST
1. Decrease replacement fluid to 10 - 15 ml/kg/hour.
2. Continue to trend labs every 4-6 hours. If potassium starts to increase.
a. Switch to 0K bath OR
b. Increase replacement fluid to 20 - 25 ml/kg/hr.
1. Continue CVVHD for 12 hours/24 hours using 3L of replacement fluid
2. Continue to trend labs every 4-6 hours. If potassium starts to increase.
a. Switch to 0K bath OR
b. Increase replacement fluid by additional 1 L until potassium is stable
1. Continue CVVHD using 20 - 25 ml/kg/hr of replacement fluid
2. Continue to trend labs every 4-6 hours. If potassium starts to increase.
a. Switch to 0K bath OR
b. Increase replacement fluid by additional 1 L until potassium is stable

Ultrafiltration Rate

This is the rate at which the machine removes volume from the patient. For example, if this is set at 100ml/hr, 2.4L will be removed from the patient over the next 24 hours. In the absence of overt hypervolemia, we suggest initially setting the ultrafiltration rate to 0 or equal to all of the patient's hourly fluid input (IV fluids, antibiotics, etc.). However, if the patient has significant volume overload (e.g., pulmonary edema), this can be titrated to achieve a net negative fluid balance of 1-2L per day (all quantifiable inputs minus all quantifiable outputs).

Since these patients have experienced recent trauma, often with associated coagulopathy, and citrate anticoagulation is not available in the deployed setting, we suggest not anticoagulating patients for the sole purpose of CRRT. Should filter clotting become an issue, the following maneuvers may be useful: 1) increase blood flow rate or 2) decreasing/stopping ultrafiltration rate to decrease hemo-concentration. Another strategy that is considered safe is adding a pre-filter (into the blood line coming out of the patient and going to the NxStage System One) infusion of normal saline at 100 ml/hr (you need to account for this input when calculating ultrafiltration rate) to help dilute blood in dialyzer. As a

last resort and only if there is recurrent clotting compromising the delivery of this therapy and the patient is not a bleeding risk, you may consider an infusion of 500 units per hour of heparin. This should be infused pre-filter as previously noted. If needed, this can then be titrated to achieve an aPTT 1.5-2 times normal.[15]

DRUG DOSING

General antimicrobial dosing for CVVHD (recommendations below in Table 2 are based on data using CVVH, possible increase in drug clearance with CVVHD modality).

Table 2. General antimicrobial dosing for CVVHD

Antibiotic	Recommend dose for CVVHD
Vancomycin	20 mg/lg/24hrs as continuous infusion
Daptomycin	8 mg/kg every 48 hours
Piperacillin/Tazobactam	3.375 g every 6 hours, each dose infused over 3 hours
Cefepime	Loading dose of 2,000 mg followed by 1,000-2000 mg every 12 hours
Meropenem	1 g every 8 hours
Imipenem/cilastatin	500 mg every 6 hours
Amikacin	Loading dose of 10 mg/kg, then 7.5 mg/kg every 24-48 hours
Levofloxacin	Loading dose of 500-750 mg then 250 mg every 24 hours

NUTRITION

Patients on CRRT have an increased nutritional demand due to clearance delivered by CRRT. Higher dose clearance requires increased nutrient demands.

Table 3. Nutritional recommendations for patients on CRRT

	Recommendation	Notes
Energy requirements	25-35 Kcal/kg	Fluids containing lactate, citrate, and acetate can also contribute to caloric intake.
Protein Requirements	1.5 g/kg/day	Can consider glutamine supplementation 0.3-0.5 g/kg/day. If BUN continues to rise despite CRRT consider reduction in protein intake.

ACUTE PD

If patients do not respond to medical management, and NxStage System One is not available, consider acute PD.

While its use has been supplanted by CRRT in most developed nations, PD is an established treatment for AKI with electrolyte disturbances such as hyperkalemia.[16] PD relies on the diffusion and convection of solutes from the blood into a fluid across the peritoneal membrane. For the purposes of potassium clearance, a fluid that is low in potassium is infused into the peritoneal space. Potassium then flows down its concentration gradient from the blood and extracellular space into this fluid. Once equilibration is achieved (i.e. the concentration in the blood and fluid are equal) no further potassium goes into the fluid. Therefore, the fluid must be exchanged periodically to maintain clearance.

Because recent abdominal surgery is considered a relative contraindication to PD,[17] the efficacy of PD and the complications associated with PD in trauma patients that have undergone laparotomy and/or have bowel in discontinuity are largely unknown. However, there are case reports of PD being used in combat casualties with recent laparotomy.[20] If no other forms of renal replacement therapy are available and the patient cannot be evacuated to a higher echelon of care, consider PD, even in patients without an intact peritoneal lining.

In order to perform PD, access to the peritoneal space is needed. Once access is established, there are three components to a PD prescription: fluid type, exchange volume, and dwell time.

Catheter Placement

Under normal circumstances, specialized catheters are used for PD. These are not usually available in the deployed setting, which require available supplies to be repurposed. Jackson-Pratt (JP) abdominal drains and pediatric chest tubes have both been used as improvised PD catheters in theater.[18,20] Nasogastric tubes central lines, suprapubic and urinary catheters have also been recommended as improvised catheters.[16,18] While catheters can be placed via a variety of methods (including modified Seldinger and laparoscopic techniques), most patients in the forward deployed environment will require open surgical approaches.[20] Under ideal circumstances, PD catheters should be tunneled in order to decrease the risk of peritonitis.[16] This may not be an option in the austere, forward deployed environment where the use of stoma appliances as a protective dressing to prevent the described infections.[20]

Fluid Type

While specialized PD fluids are made commercially, they are not normally available in deployed locations. However, a variety of fluids can be used for field expedient PD (Refer to Appendix D for this section). If the indication is hyperkalemia, use a solution with a potassium concentration of 0 at the initiation of PD. Monitor the patient's potassium level and once normalized, change the fluid to a concentration of ~4meq/L by using one of the alternate fluids. Note that in the setting of shock or liver failure, a solution with bicarbonate (not lactate) will reverse acidemia more rapidly.[19] If acidemia persists after correction of potassium in patients in shock, ~4meq/L of potassium should be added to the "potassium free solution" of choice to avoid using lactate as a buffer. The amount of fluid removed by PD is determined by two factors: 1) the amount of time the fluid is in the abdomen and 2) the concentration of dextrose in the solution. As others have recommended,[15] we suggest that a concentration of ~1.5% dextrose be used for patients that are euvolemic or hypovolemic. For patients that are moderately or severely volume overloaded, we suggest ~2.5% and ~4.5% dextrose concentrations, respectively. Note that a 4.5% dextrose fluid can remove volume very quickly (up to 1L in 4 hours),[15] therefore you should limit its use to hemodynamically stable patients with severe, life-threatening pulmonary edema.

Exchange Volume

The "exchange volume" is the volume of fluid infused into the peritoneal space. Removing the fluid after the dwell and instilling fresh fluid is referred to as an "exchange." We recommend starting with a volume of 1L per exchange for and then increasing to 2L per exchange if tolerated. We recommend continuous exchanges until potassium is <6.0 mEq/L; then can decrease to 5 cycles of 2L exchanges. The volume infused may be limited by fluid leakage around the surgical site, especially in patients with large laparotomy incisions or open abdomens. To avoid leakage, keep the patient in the supine position during PD.

Dwell Time

The length of time that the fluid is allowed to sit in the peritoneal space between exchanges is known as the "dwell time." We recommend frequent exchanges (defined as an initial dwell time of 1 hour) until the initial therapeutic goal has been achieved (e.g., potassium normalized or acidemia reversed), at which point the dwell time can be extended to every 2-4 hours with close monitoring.

In the forward deployed setting, the use of PD can be complicated by fluid leakage (especially if the abdomen must be left open) and also by the development of abdominal compartment syndrome with fluid infusion. These may severely limit the volume of fluid that can be infused and allowed to dwell. In this case, the fluid can be continuously exchanged.[20] In practice, this means instilling fluid into the peritoneum from one site (e.g., from a pediatric chest tube or JP drain) while simultaneously removing fluid from another site (e.g., a different drain, or wound vac if available.) If continuous exchange of fluid is utilized, the inflow and outflow ports in the peritoneal space should be physically separated as much as possible to maximize the surface area that the fluid passes by as it goes from the inflow catheter to the outflow catheter. The outflow port should if possible be in the most dependent part of the abdomen (the pelvis).

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Patients with acute kidney injury or hyperkalemia (potassium > 6.0 or hyperkalemia diagnosis code or documentation of EKG changes consistent with hyperkalemia).

INTENT (EXPECTED OUTCOMES)

1. All patients with K > 6.0 and/or EKG changes consistent with hyperkalemia receive appropriate medical treatment at the same level of care where diagnosed. (See drugs listed in Appendix A.)
2. All patients with persistent hyperkalemia despite medical management receive RRT (CRRT or peritoneal dialysis) or documenting why RRT is not implemented.
3. Indication for initiation RRT is documented.

PERFORMANCE/ADHERENCE MEASURES

- Number and percentage of patients in the population of interest who receive medical treatment for hyperkalemia at the same level of care where diagnosed.
- Number and percentage of patients who receive RRT who have the indication for RRT documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: INITIAL MEDICAL MANAGEMENT FOR HYPERKALEMIA

Drug/ Treatment	Dose & Route of Administration	Mechanism of Action	Time to Onset	Duration of Effect	Caution/Contraindication	Other Comments
Stabilize Cardiac Membranes						
Calcium gluconate	1000mg=one 10ml "amp" of 10% (100mg/mL) solution; infused IV over 2-3 mins	Stabilizes myocyte membrane electrical activity	Immediate	30-60 mins	Caution if pre-existing hypercalcemia	Can be administered via peripheral IV; repeat in 5 mins for persistent EKG changes
Calcium chloride	1000mg=one 10ml "amp" of 10% (100mg/mL) solution; infused IV over 2-3 mins	Stabilizes myocyte membrane electrical activity	Immediate	30-60 mins	Administration via central line preferred (can damage small vessels, cause tissue necrosis); caution if pre-existing hypercalcemia	Repeat in 5 mins for persistent EKG changes
Shift Potassium Intracellularly						
Insulin, regular	Give 50 mL 50% dextrose first unless blood glucose is >250. Then give insulin 10 units by IV bolus.	Shifts potassium intracellularly by way of Na-K ATPase pump	10-20 mins	4-6 hr	Caution if hypoglycemia. Insulin is renally secreted in setting of anuria/oliguria can cause prolonged hypoglycemia.	Check blood glucose within one hour of administration. If oliguric/anuric can consider starting D5W gtt to prevent hypoglycemia. Insulin should be kept cold until use, consider packing in personnel insulin carriers.
Albuterol	10 mg nebulized, over 10 mins	Shifts potassium intracellularly by way of Na-K ATPase pump	20-30 mins	1-2 hr	Can cause tachycardia	Has additive effect with insulin tx
Potassium Binders						
BEST Sodium Zirconium Cyclosilcate (Lokelma)	10 gram (in water) PO TID for 48 hours, followed by 10 g PO daily	Mechanism not fully understood, exchanges hydrogen and sodium for potassium in small and large intestines	1 hour	Variable (up to 48 hrs of treatment time)	No studies conducted on patient with bowel obstruction or impaction. Avoid in patients with severe constipation, bowel obstruction or impaction.	Preferred oral potassium binder Monitor for signs of edema, can increase diuretics if indicated.
BETTER Patiromer (Veltassa)	8.4 g/16.8g (in water) PO once daily	Increases potassium removal by fecal excretion, exchanges calcium for potassium in the large intestine.	~7 hours	24 hours	Avoid in patient with bowel obstruction or severe constipation. Can cause Hypomagnesemia.	May decrease effectiveness of oral Ciprofloxacin. Administer Ciprofloxacin 3 hours before or after Patiromer. Patiromer must be refrigerated or used within 3 days after removed from refrigeration.
GOOD Sodium polystyrene sulfonate (Kayexalate)	30 grams PO	Exchanges sodium for potassium in the large intestine	>2 hours	Variable	Case reports of colonic necrosis; avoid in setting of bowel obstruction or following bowel injury or surgery; may be of limited utility in setting of severe hyperkalemia.	Can repeat every 4-6 hours; consider initial dose of 45-60 grams in body weight >80 kg
Promote Kaliuresis						
Furosemide	40mg IV	Impairs renal potassium reabsorption	5 mins	2 hours	If hypotensive or volume depleted consider administration with balanced crystalloid and IV diuretics.	May require larger does (up to 200mg) or be ineffective in setting of acute kidney injury.

APPENDIX B: CONTINUOUS RENAL REPLACEMENT THERAPY - NXSTAGE SYSTEM ONE

Suggested starting prescriptions and dosage

	Recommendation	Notes
Mode	CVVHD	CVVHD should be considered over CVVH because it is more efficient per liter of volume used.
Blood Flow Rate	200-400 ml/min	The blood flow rate should be increased as much as tolerated by the access pressures and machine alarms to avoid clotting. We suggest maintaining flows of at least 200 cc/min.
Replacement Fluid Type	0K, 4K	If 0K or 4K fluid is not available, CRRT can be performed using lactated ringer, Plasmalyte or the improvised solutions for peritoneal dialysis. Monitor BMP, magnesium, ionized calcium, and phosphate.
Replacement Fluid Rate	3L per hour initially	See flow chart under replacement fluid rate for further guidance.
Ultrafiltrate Rate	0 ml/min	If desired, fluid can be removed via ultrafiltration. In the acute setting, barring overt hypervolemia, fluid removal should be avoided. However, consider setting the ultrafiltration rate to the patient's hourly "In's" to avoid hypervolemia.

APPENDIX C: IMPROVISED SOLUTIONS - CONTINUOUS RENAL REPLACEMENT THERAPY

	0.45% NaCl	8.4% NaHCO3	50% Dextrose	3% NS	50% MgSO4	CaCl2
Volume (mL)	1000	40	2.5	80	0.3	2.5

* Note that this fluid does not contain potassium or phosphate supplementation.

APPENDIX D: IMPROVISED SOLUTIONS FOR PERITONEAL DIALYSIS

Starting Fluid	Addition(s)	Ending Concentrations
Potassium Free Solutions		
1 Liter ½ Normal Saline Na 77 mEq/L, Cl 77 mEq/L	40ml of 8.4% Bicarbonate 35ml of 50% Dextrose 60ml of 3% Saline	Na 130 mmol/L, K 0 mmol/L, Ca 0 mg/dL, Cl 95 mmol/L, bicarbonate 35 mmol/L, Osm 338 mOsm/kg, Dextrose 1.54%
1 Liter ½ Normal Saline Na 77 mEq/L, Cl 77 mEq/L	40ml of 8.4% Bicarbonate 60ml of 50% Dextrose 65ml of 3% Saline	Na 129 mmol/L, K 0 mmol/L, Ca 0 mg/dL mmol/L, Cl 95 mmol/L, bicarbonate 34, Osm 388 mOsm/kg, Dextrose 2.57%
1 Liter ½ Normal Saline Na 77 mEq/L, Cl 77 mEq/L	43ml of 8.4% Bicarbonate 105ml of 50% Dextrose 75ml of 3% Saline	Na 130 mmol/L, K 0 mmol/L, Ca 0 mg/dL, Cl 94 mmol/L, bicarbonate 35 mmol/L, Osm 476 mOsm/kg, Dextrose 4.29%
Potassium Containing Solutions		
1Liter Lactated Ringers Na 130 mEq/L, K 4 mEq/L, Ca 2.7 mEq/L, Cl 109 mEq/L, Lactate 28, Osm 273 mOsml/L	30ml 50% Dextrose	Na 126 mmol/L, K 3.9 mmol/L, Ca 2.6 mg/dL, Cl 106 mmol/L, Lactate 27 mmol/L, Osm 339 mOsm/kg, Dextrose 1.46%
1Liter Lactated Ringers Na 130 mEq/L, K 4 mEq/L, Ca 2.7 mEq/L, Cl 109 mEq/L, Lactate 28 mEq/L, Osm 273 mOsml/L	53ml of 50% Dextrose 10ml of 3% Saline	Na 127 mmol/L, K 3.8 mmol/L, Ca 2.5 mg/dL, Cl 107 mmol/L, Lactate 26 mmol/L, Osm 392 mOsm/kg, Dextrose 2.49%
1Liter Lactated Ringers Na 130 mEq/L, K 4 mEq/L, Ca 2.7 mEq/L, Cl 109 mEq/L, Lactate 28 mEq/L, Osm 273 mOsml/L	95ml of 50% Dextrose 25ml of 3% Saline	Na 128 mmol/L, K 3.6 mmol/L, Ca 2.4 mg/dL, Cl 109 mmol/L, Lactate 25 mmol/L, Osm 481 mOsm/kg, Dextrose 4.24%

*1L fluid bags may contain extra fluid (40-60ml), this additional volume is not included in these calculations as it will not make a significant clinical difference.

These suggested fluids are based on what is likely to be available in the forward deployed setting. In case other fluids need to be improvised, an example of how these solutions were derived may be instructive. These calculations are based on the total amount of the substance divided by the total volume. For example, the Na concentration in the first fluid in the table:

1. Total amount of Na: amount in ½ NS (77meq/L x 1L=77meq) plus amount in 8.4% bicarbonate (1000meq/L x 0.04L= 40meq) plus amount in 3% saline (513meq/L x 0.06L= 30.78meq). Therefore, total amount is 77+40+30.78=147.78. Note that there is no Na in 50% dextrose.
2. Total volume: Volume of ½ NS plus volume of 8.4% bicarbonate plus volume of 50% Dextrose plus volume of 3% saline. 1+0.04+0.035+0.06=1.135 L.
3. Dividing the total amount of Na (147.78 meq) by the total volume (1.135L) equals 130.20264 or about 130 meq/L.

APPENDIX E: ASSESSING FLUID STATUS

	Hypervolemia	Euvolemia	Hypovolemia
Cardiovascular	Normotension/Hypertension, Strong Peripheral Pulses, Negative PLR test, Peripheral Edema*	Normotension, Normal Peripheral Pulses, indeterminant PLR	Hypotension, Weak/diminished Peripheral Pulses, Positive PLR test, Pallor, Tachycardia
Pulmonary	Crackles, Dyspnea, Pulmonary Edema, Pleural Effusion*	Eupnea, Clear Breath Sounds	No specific findings
Ultrasound Findings	Pulmonary B lines, Inferior Vena Cava (IVC) remains completely dilated on inspiration, Pleural Effusion*, Ascites*	Pulmonary A lines, Sea Shore Sign, Inferior Vena Cava (IVC) compresses less than 50% on inspiration	Positive eFAST exam, Collapsing or "Kissing" ventricles, IVC compresses more than 50% on inspiration

**- indicates late findings*

PLR= Passive Leg Raise. To conduct PLR: while patient is lying flat obtain blood pressure, then raise legs to 45 degrees and hold for 60-90 seconds. After holding for 60-90 seconds obtain blood pressure. Positive PLR test is when difference of systolic blood pressures from diastolic blood pressures is equal to or greater than 10%.

Limitations: Intra-abdominal hypertension, head trauma/increased ICP, lower extremity Deep vein thrombosis (DVT), amputated leg.

Assessing volume status is difficult, even among medical professionals. The above stated clinical and imaging findings are used to serve as a guideline and volume status cannot be determined based on one sole finding, rather a combination of clinical and imaging findings.

APPENDIX F: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Hypothermia: Prevention and Treatment

This document provides updates to the Hypothermia Prevention Monitoring and Management CPG from 2012 and is applicable from the pre-hospital phase of care and beyond.

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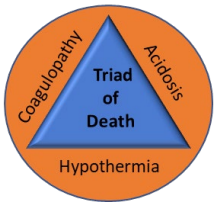
HYPOTHERMIA

PREVENTION & TREATMENT

Published by the Joint Trauma System,
the DoD Center of Excellence for Trauma

● Prehospital ● Tactical Combat Casualty Care ● En Route Care ●
Prolonged Casualty Care ● Tips & Tricks ● Troubleshooting

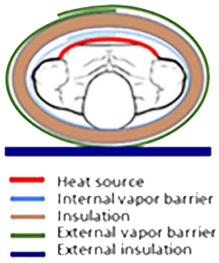
Hypothermia is a key contributor in the Triad of Death



Trauma-induced Hypothermia

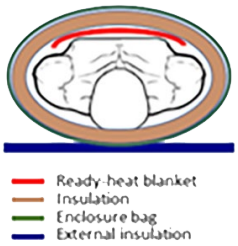
mild: 34-36 °C
moderate: 32-34 °C
severe: <32 °C

- ✓ **Replace wet clothing** with dry clothing
- ✓ **Monitor patient's temperature** during rewarming. Convert to continuous temperature monitoring.
- ✓ **Warm resuscitation fluids/blood products** to 38-42 °C with a flow rate up to 150 ml/min



Use passive and active methods of rewarming

- Passive warming: utilizing the patient's heat generation via shivering/metabolism.
- Active warming: applying an external heat source



METRICS

- Temperature and route will be documented on all patients upon admission and discharge.
- Core temperatures are obtained on patients with temperature < 97° F and > 100° F.
- Warming measures and sustainment of core temperature > 96°.F are initiated on all patients.

Defense Health Agency
JOINT TRAUMA SYSTEM ®

Clinical tips based on the Hypothermia: Prevention and Treatment CPG, Jun 2023, published by the Joint Trauma System.

JTS CPGs : HTTPS://JTS.HEALTH.MIL/INDEX.CFM/PI_CPGS/CPGS

SUMMARY OF CHANGES

1. Incorporates Tactical Combat Casualty Care (TCCC) Guidelines for Hypothermia from 2021.
2. Expands prevention of trauma-induced hypothermia to include not only trauma patients in hemorrhagic shock, but also burns and cerebrospinal injuries.
3. Outlines characteristics of hypothermia prevention and treatment systems that can be utilized in addition to the more widely used system, the Hypothermia Prevention and Management Kit (HPMK) and the Heat Reflective Shell (HRS).
4. Provides option if unable to remove wet clothing to include the enclosure of the casualty with a vapor barrier over the wet clothing.
5. Recommends upgrading the HPMK to an insulated system as soon as possible as it is non-insulated and therefore only suitable for short term hypothermia prevention.
6. Provides specific target for warm resuscitation fluids/blood products to 38-42 degrees Celsius.
7. Adds Prolonged Casualty Care (PCC) guidelines to the CPG.
8. Expands Field Expedient 'Tricks of the Trade' in the CPG.

BACKGROUND

Hypothermia, coagulopathy, and acidosis are the physiological derangements constituting the "triad of death" in trauma patients.[1–4] Here, we use the term trauma-induced hypothermia (TIH) as it relates more specifically to combat trauma including hemorrhagic shock, cerebrospinal injury, and burns - all of which lead to a significantly increased risk of mortality and presents as a separate, more severe entity than non-traumatic or environmental hypothermia. TIH is a ubiquitous concern regardless of the environment as it can occur even in warm climates, as has been the experience in the Middle East.[5]

The Hypothermia CPG, initially published in 2006, was one of the first JTS CPGs. Prior to this, the rate of hypothermia (Temp <97 F) in patients arriving to the first role of care was as high as 15.42% in 2004. The rate initially dropped by over half to 7.26%. While it slowly increased again, it should be noted that missing temperature data in the DoD Trauma Registry (DoDTR) was as high as 42% when large volumes of casualties were being seen in 2003. The rate of missing data dropped significantly when the CPG was published yet remained in the 10-20% range. It is unclear if the true incidence was higher before 2006, but this potentially shows a Hawthorne effect and the effectiveness of tracking information to inform clinical practice. Figure 1 shows the trend in hypothermia by U.S. Military patients by year at any medical treatment facility (MTF). The purpose of this CPG is to provide guidance for the prevention and management of TIH in the combat casualty throughout the escalating roles of care.

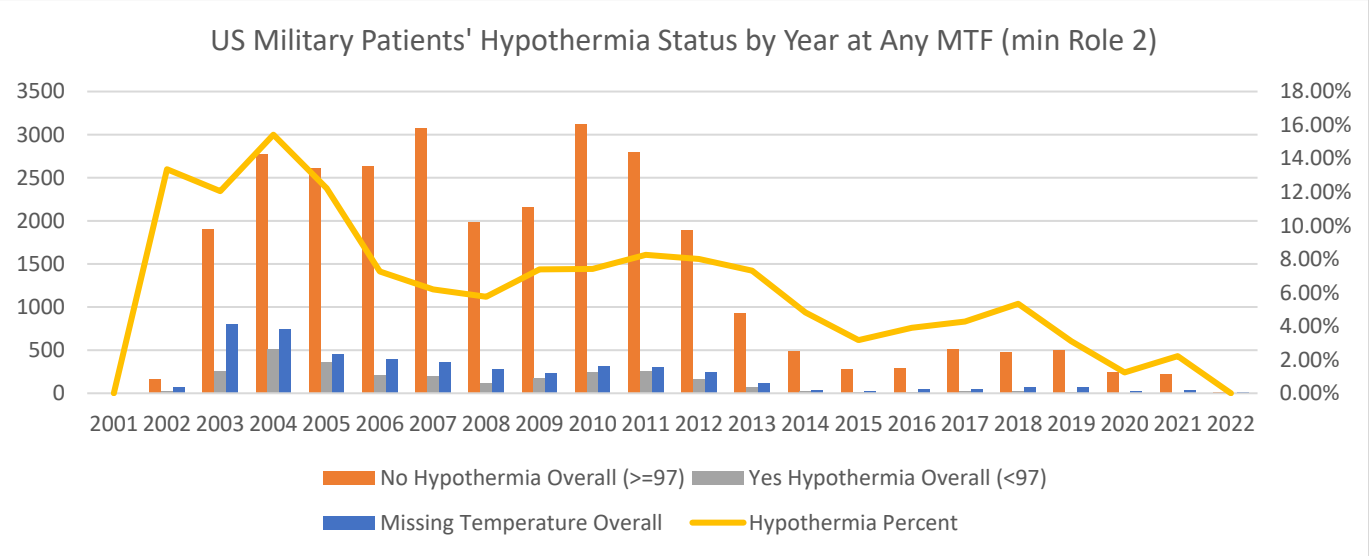
Current literature suggests that about one to two-thirds of trauma patients are hypothermic upon presentation to the emergency department. The mortality of hypothermic patients is approximately twice that of similarly injured normothermic patients.[7-10] In another large study of trauma patients requiring massive transfusion, hypothermia (< 36 deg C) on arrival was an independent predictor of mortality and associated with increased blood product

TIH is classified as mild: 34-36 °C, moderate: 32-34 °C, and severe: <32 °C.[6]

consumption.[11-13] Furthermore, studies in civilian trauma have shown >80% of non-surviving patients arrived hypothermic with a core temperature < 34 deg C.[12] In both civilian and military trauma, 100% mortality has been demonstrated when core temperature reached < 32 deg C.[14,15] When hypothermic patients fall below the thermoregulatory threshold for shivering (around 30 deg C), shivering heat production ceases. Therefore, these patients have lost the ability to generate heat and will continue to cool unless actively rewarmed by external sources.[16] This can be further exacerbated by pharmacologic treatment with sedatives and paralytics.[17,18]

Innovation and improved outcomes-based research over the past two decades have improved survivability via addressing coagulopathy and acidosis .[1,5,19–22] Early recognition and treatment of hypothermia is an equally important consideration that begins at the point of injury and should be implemented for all combat casualties, particularly patients at risk of experiencing shock. As it is labor and resource intensive to re-warm a casualty, measures to prevent hypothermia should begin as soon as possible with thermal wraps and warmed resuscitation products.[5,23,24] There are varying degrees of abilities and resources availability at each echelon role of care, which are discussed in the following sections.

Figure 1. DoDTR Hypothermia Rate in US Combat Casualties (CENTCOM/AFRICOM) from 2001 to 2022.



The highest percentage of hypothermia occurred in 2004. The first hypothermia CPG was published in 2006. Over time the missing temperature recordings from the records decreased and starting in 2014, the percentage of combat casualty with hypothermia was less than 5%.

TREATMENT

PREHOSPITAL – TCCC

1. Take early and aggressive steps to prevent further body heat loss and add external heat, when possible, for both trauma and severely burned casualties.
2. Minimize casualty's exposure to cold ground, wind, and air temperatures. Place insulation material between the casualty and any cold surface as soon as possible. Keep protective gear on or with the casualty if feasible.
3. Replace wet clothing with dry clothing or another thermal barrier (i.e. sleeping bag), if possible, and protect from further heat loss. If unable to replace the dry clothing, wrap an impermeable vapor layer around the casualty. Leave the vapor barrier in place until a warm environment has been reached.
4. Place an active heating blanket on the casualty's anterior torso and under the arms in the axillae (to prevent burns, do not place any active heating source directly on the skin or wrap around the torso). Avoid placing the heat in high pressure areas (i.e. on the back of a supine patient). Regularly monitor the skin under these areas for burns. [25,26,27] See below for information on hypothermia wraps.
5. Enclose the casualty with the exterior impermeable enclosure bag. As soon as possible, upgrade hypothermia enclosure system to a well-insulated enclosure system using a hooded sleeping bag or other readily available insulation (i.e. wool blankets) inside the enclosure bag/external vapor barrier shell. The HPMK is non-insulated and therefore suitable only for short term hypothermia prevention, especially in cold climates.
6. Pre-stage an insulated hypothermia enclosure system with external active heating for transition from the non-insulated hypothermia enclosure systems; improve upon existing enclosure system when possible.
7. Use a battery-powered warming device to deliver IV resuscitation fluids, in accordance with current TCCC guidelines, at flow rate up to 150 ml/min with a 38°C output temperature. (See Appendix A.)
8. Protect the casualty from exposure to wind and precipitation on any evacuation platform.
9. The priority remains the recognition of shock and implementation of heat-loss prevention techniques as outlined above. Rewarming hypothermic patients can be achieved passively (utilizing the patient's heat generation via shivering/metabolism) and actively (applying an external heat source). If available, active re-warming should be initiated along with passive warming interventions.
10. Active heating: there are no contraindications other than do not use on a heat casualty or those not at risk for hypothermia.[28,29] See Figure 2 for the indications, contraindications, and other considerations for active rewarming below.
11. Regarding extremity/trauma and tourniquets, research is ongoing regarding the use of extremity tourniquets.[30] Priority in TIH is to prevent additional core cooling to mitigate the effects of shock, hypothermia, coagulopathy, and acidosis. Providers may consider leaving the extremity with a tourniquet outside of the insulating wrap, in order to monitor for re-bleeding. This is not recommended as standard practice as the priority should be on the life saving measures of TIH prevention.
12. Utilize an insulated hypothermia wrap with an active heating source for all potentially hypothermic trauma patients. Systems that include more insulation and active heating sources perform better for treating/preventing hypothermia but may present limitations when considering portability for field applications.[5,24] One of the more widely used systems due to portability, cost, and effectiveness is the HPMK which contains the Ready-Heat Blanket (RHB) - an active warming source and the HRS - essentially an impermeable vapor layer (previous version was the Blizzard blanket).

13. Other options include user assembled kits or commercial hypothermia kits, but the recommended characteristics of any hypothermia prevention/treatment system are outlined below. A list of active and passive external rewarming options for field use are shown in (Table 2 - Appendix A).
14. Burrito wrap concept with 5 layers as referenced per Bennet et al.
15. Active heat source applied to the torso in the following order of precedence: axillae, chest, back. These are the areas with the highest potential for heat transfer.[24,25,31] The heat source should not be in direct contact with the patient's skin.
16. Internal vapor layer (plastic or foil sheets)
17. Hooded sleeping bag or other insulation (wool blankets)
18. Complete with an outer impermeable layer wrapped around all other layers to prevent heat loss, water entry and to block the wind.[25]
19. Use a ground-insulating pad

Figure 2. Improvised wrap with internal vapor barrier

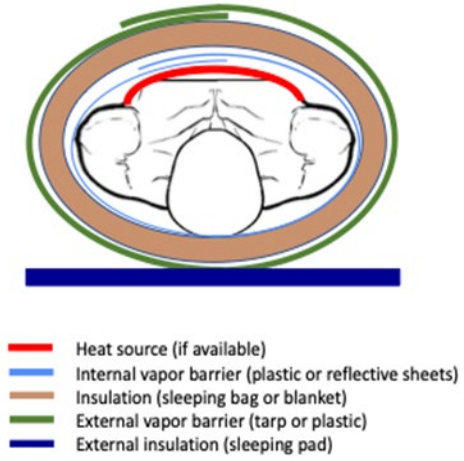

Heat source (if available)
Internal vapor barrier (plastic or reflective sheets)
Insulation (sleeping bag or blanket)
External vapor barrier (tarp or plastic)
External insulation (sleeping pad)

Figure 3. HPMK with improvised insulation (wool blanket).

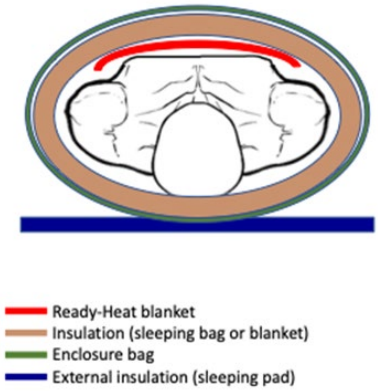


Table 1. Indications, contraindications, and other considerations for active warming.[5]

	Criteria	General Comments
Indications	· Moderate to severe trauma · Central nervous system trauma · Burn patients 20% TBSA with 2nd or 3rd degree. · Alerted level of consciousness; unresponsive; in cold environment. · Impaired shivering; in cold environment	Combat casualties with moderate to severe trauma should be managed with active heating inside a hypothermia wrap as soon as possible.
Contraindications	· None for TIH · Only when a casualty presents with signs and symptoms of hyperthermia (severe heat illness)	· There are no restrictions to use active warming inside a hypothermia wrap for TIH casualties. · It is contraindicated to use active warming for any casualty who presents with heat exhaustion or exertional heat stroke.
Safety	1st, 2nd, 3rd degree burns	· Never place any active heat source directly on skin. Follow manufacture directions for correct use of heating source.
Complications	Potential for enhanced muscle damage on an extremity distal to a tourniquet.	· Increased temperature of non-perfusion extremity distal to a tourniquet can cause further muscle damage. · Attempt to keep that part of the extremity from increasing temperature. · Do not pack extremity with a tourniquet in ice or snow.

~2-4 HOURS - TCCC, ERC, PCC

1. Continue and/or initiate above hypothermia interventions.

2. Upgrade hypothermia enclosure system to a well-insulated enclosure system using a hooded sleeping bag or other readily available insulation inside the enclosure bag/external vapor barrier shell. Best: Improvised hypothermia wrap with high-quality insulation with cold-rated sleeping bag combined with heat source, internal vapor barrier, outer impermeable enclosure.

3. Continue to use a battery-powered warming device to deliver blood at a flow rate up to 150 ml/min hr with a 38°C output temperature. (Table 2).

4. Convert to continuous temperature monitoring.
   - **Minimum**: Scheduled temperature measurement with vital sign evaluations.
   - **Better**: Continuous forehead dot monitoring.
   - **Best**: Continuous core temperature monitoring.

5. When using the HPMK Ready-Heat Blanket, perform frequent skin checks to monitor for contact burns.

~>6 HOURS - ERC, PCC

Continue and/or initiate the ruck/truck phases as detailed above. Replace Ready-Heat Blanket when using >10 hours.

ROLE 2 AND ROLE 3 PRIORITIES

- On patient arrival to the Role 2/3 facility, every effort must be made to prevent hypothermia; this should be a priority throughout resuscitative efforts and operative procedures. Control of ambient air temperature should be utilized to maintain a warm environment.
- Wet clothing and blankets should be removed immediately and a warming device applied if not done prior to arrival or if the device was damaged during transport.
- Use of warmed blood and blankets is indicated, where available, as well as forced air warming devices (Bair Hugger) as applicable.
- Continuous temperature monitoring is preferred, and temperatures should be documented on arrival to and discharge from the facility. A temperature sensing Foley catheter is a viable option to monitor temperature as well as the response to ongoing resuscitation efforts.
- If non-core temperature (oral, axillary, or tympanic) is outside of an expected range (<97F or >100F), use core temperature (rectal or esophageal) measurement for best accuracy.

EN- ROUTE CARE (ERC)

***NOTE**: Patient packaging with treatment for TIH is a core skill that should be deliberately planned and rehearsed prior to mission execution. A patient packaged for hypothermia prevention/treatment is difficult to access. Medical providers need to be cognizant of this fact and have a plan to monitor their patient's status as well as their prior medical interventions.*

- Ensure hypothermia management from the field is still in place and has not moved and or shifted during turnover. Ensure the hypothermia management system is covering the back and the system is protecting the patient from wind blowing over or under the casualty, especially in a rotary wing environment.
- Use of vehicle or aircraft Environmental Control Systems (ECS) should be used to create an ambient control temperature to allow passive room warming. ECS Systems can be unreliable, especially in rotary wing when power is limited. In preplanning, the ECS can be used to set a warm environment prior to or after receiving the casualty, to prevent drastic temperature loss.
- The use of continuous temperature monitoring should be conducted to establish and track warming trending.
- When moving patients in the maritime environment, doubling up of outer layering impermeable systems should be utilized to protect the patient from winds and sea spray.

FIELD "TRICKS OF THE TRADE" + ANECDOTAL "TROUBLE SHOOTING"

- Use RHB/active rewarming systems in maritime environment.
- On scene materials/clean trash bags or saran wrap may be helpful improvised insulation materials.

- Vehicle heating systems may help direct hot air to a patient in a field expedient Bair Hugger in certain platforms. This requires prior coordination and setup and is a non-standard equipment load.
- Use of thermal heat packs (crush packs, Ready Heat 1 Panel Blanket, MRE heater, even Foley bag in extremis) or body heat for fluid pre-warming (of most utility in Ruck-Truck-House phases when fluid warmers might be in short supply)
  Note: Do not place directly on skin to prevent thermal injury to patient.
- Expect issues with finger pulse-ox devices. If value shown does not correlate to patient presentation, remember to treat the patient, not the device. Taping heat pack over hand, but not in direct contact with the skin and device, may aid in accuracy/operation.
- In extreme cold weather (below -20°F), exhalation gas from intubated patients may cause ice to instantly form in the ET tube and vent tubing. Care should be taken to insulate all interventions while exposed to these conditions.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All trauma patients meeting DoDTR inclusion criteria with ISS>1.

INTENT (EXPECTED OUTCOMES)

- Temperature and route will be documented on all patients upon admission and discharge.
- Core temperatures are obtained on all patients with temperature <96 F and > 100° F.
- Warming measures and sustainment of core temperature > 96°.F are initiated on all patients.

PERFORMANCE/ADHERENCE MEASURES

- Temperature and route will be documented on all patients upon admission and discharge.
- Core temperatures are obtained on all patients with temperature <96 F and > 100° F.
- Warming measures and sustainment of core temperature > 96°.F are initiated on all patients.

DATA SOURCES

- Patient Record
- DoDTR

SYSTEM REPORTING & FREQUENCY

- The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.
- The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.
- For more information on metrics, email: dha.jbsa.healthcare-ops.list.jts-pips@health.mil

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A – EQUIPMENT LIST

SECTION 1: PATIENT WARMING[1,2]

Table 1. Passive Rewarming Methods

- Level A: Evidence from multiple randomized trials or meta-analyses.
- Level B: Evidence from a single randomized trial or non-randomized studies.
- Level C: Expert opinion, case studies, or standards of care.
- NE = not effective; √ = mildly effective; √√ = moderately effective; √√√ = highly effective

	Prehospital	Reference	Rewarming	Level	Comments
Passive Rewarming Methods	Sleeping bag	Giesbrecht et al.[3]	√	B	Insufficient alone to prevent heat loss; works better with vapor barrier wrap with a when patient is shivering.
	Impermeable outer layer with sleeping bag insulation (burrito wrap)	Grissom et al.[4]	√√	B	Traditional passive rewarming approach in austere medicine courses. Works well with shivering patient in mild hypothermia to retain heat production and prevent body heat loss; active external heating source not required.
	Wool Blanket (WB)	Allen et al.[5]	NE	C	Prospective Randomized Study. No human volunteers. A single WB was least effective to prevent heat loss in fluid bag torso simulation.
	Space Blanket (SB)	Allen et al.[5]	NE to √	C	Prospective Randomized Study. No human volunteers: SB was placed over the simulation torso and tucked in. Was not as effective to prevent heat loss but better than the wool blanket.
	Human Remains Pouch (HRP)	Allen et al.[5]	√	C	Prospective Randomized Study. No human volunteers. The HRP did not maintain torso bladder temperature better than the wool blanket.
	HRS	Allen et al.[5]	√√√	C	Prospective Randomized Study. No human volunteers. New shell version was used as a passive bag. There was no statistical difference between the HRS and BB in heat loss between Gen 1 vs. Gen 2 HPMK.
	Hot Pocket (HP) (HRP, wool blanket, and space blanket)	Allen et al.[5]	√√√	C	Prospective Randomized Study. No human volunteers. The use of the HP system was very effective and one of two best passive methods of heat loss prevention, which performed the same as two of the three active heating methods tested at 120 minutes.
	Blizzard Blanket (BB)	Allen et al.[5]	√√√	C	Prospective Randomized Study. No human volunteers. The use of the BB alone was one of two best passive methods of heat loss prevention, which performed the same as two of the three active heating methods tested at 120 minutes.
	Vapor barrier + Hypothermia wrap	Thomassen et al.[6] Henriksson et al.[7] Henriksson et al.[8]	√√√	A	Strong evidence in favor of vapor barrier wrapped around human volunteers who were then placed inside hypothermia "burrito" wrap system. These three studies are the evidence for the recommendations for how to assemble an improvised a hypothermia enclosure system by Giesbrecht G.[9]

Table 2. Active Rewarming Methods

- **Level A**: Evidence from multiple randomized trials or meta-analyses.
- **Level B**: Evidence from a single randomized trial or non-randomized studies.
- **Level C**: Expert opinion, case studies, or standards of care
- NE = not effective; √ = mildly effective; √√ = moderately effective; √√√ = highly effective

Active Rewarming Methods	Prehospital	Reference	Rewarming	Level	Comments
	Small Chemical Packs	Co-author Consensus	NE	C	Small chemical heat packs used for hands are insufficient heat transfer to core or to prevent further heat loss. Better options available.
	Warm IV/IO fluids/blood products	Lehavi et al.[10] Haverkamp et al.[11]	NE	A	Do not infuse fluids less than 100°F (38°C). Fluids alone not effective for core temperature rewarming. Use fluids adjunctively with HPMK during MEDEVAC
	Body to body skin contact	Giesbrecht et al.[3] Hultzer et al.[12]	√	B	Suppresses shivering in victim with skin-to-skin contact; no more effective than shivering for mild accidental hypothermia; lack of evidence for any benefit in non-shivering hypothermic patient; loss of manpower.
	Hot water bottles	Co-author Consensus	√	C	Impractical. Insufficient to transfer heat to effect core temperature. Many bottles are needed; hot water replacement every 20 min.
	Walking	Giesbrecht et al.[13]	√√	B	Use to generate heat production in cold-stressed (>35°C (95°F)) victims with shivering intact, well protected from cold, wet and wind and with observer; use with caution – may cause afterdrop, 0.91°C core temperature decrease lasting nearly 30 minutes.
	Ready-Heat Blanket	Allen et al.[5]	√√	C	Prospective Randomized Study - Whole body heat blanket – 8 hours at 104 F (40°C); wrap torso and avoid direct placement on skin; use vapor barrier as outside layer.
	HeatPac	Giesbrecht et al.[13] Kulkarni et al.[14]	√√√	B	Effective to deliver heat and maintain thermal balance; costly; long-term experience in Scandinavian militaries and in research studies; resource dependent; uses charcoal as a consumable; potential carbon monoxide risk in low ventilation space; use outdoors only. Newer options available.
	HPMK	Allen et al.[5]	√√√	C	Prospective Randomized. Did not use human volunteers, but simulated torso with fluid bladder system. Effective outcome compared to all active heating systems studied. Committee on TCCC, JTS and DoD preferred system since 2006; outer vapor barrier garment and 10-hour (110°F) chemical blanket; low cost, weight, and size.; Effective system only for short-term use due to lack of insulation; patients will get cold <60 min use in cold environments per Dutta et al.[15]
	Improvised hypothermia wrap UAS	Dutta et al.[15]	√√√√	B	Randomized controlled study with human volunteers. The user-assembled and Doctor Down systems were most effective.
	Doctor Down Rescue Wrap (DD)	Dutta et al.[15]	√√√√	B	
	HPMK	Dutta et al.[15]	√√	B	Randomized control study with human volunteers. HPMK was least effective due to lack of insulation.

	MARSARS Hypothermia Stabilizer Bag (M)	Dutta et al.[15]	√√√	B	Randomized control study with human volunteers. These two systems were not as effective to retain thermal balance when compared to the DD and UAS systems.
	Wiggy's Victim Casualty Bag (W)	Dutta et al.[15]	√√√	B	
	Ready-Heat Blanket & PrimaLoft synthetic sleeping Bag hypothermia wrap	Phillips et al.[16]	√√√	C	Single case report with high efficiency to rewarm patient.

Other Patient Warming Devices

CAUTION: *Devices A-B should NOT be placed under the patient's back or directly on bare skin. Doing so may increase the likelihood of thermal burns or render the device inoperable.*

HAWK Warming Grid

- https://combatmedical.com/product/hawk-warming-grid/
- Air activated and heat adjustable. Can reseal individual cells for optimal performance.
- Conditions below 0F may require extended time (+15 minutes) to reach operating temperature
- 4-32 hours of operation

Ready-Heat Panel Blanket

- https://www.ready-heat.com/products/military/
- Air activated, NOT heat adjustable
- Conditions below 0F require extended time (+ 30 minutes) to reach operating temperature.
- Rendered inoperable by fluids and must ensure patient is dry prior to application and keep away from potential fluid sources.
- 8-10 hours of operation

Geratherm Mini Rescue II Hypothermia Kit

- www.rgmd.com
- Currently in the SOCOM Tribalco T-5 CASEVAC Kit

Chill Buster Blanket

Wiggy's or down sleeping bag

SECTION 2: FLUID WARMING[5]

Desirable Characteristics of a Resuscitation Fluid Warming Device

▪ Portable ▪ Lightweight (~2 lbs) ▪ Small dimensions (height, width, length) ▪ Ruggedized for field use ▪ Rapid start up <30 sec ▪ Water-resistant ▪ Low noise and light signature ▪ Long-life battery powered with easy replacement ▪ Battery duration for 4 units of whole blood at ≥100 to 150ml/min	▪ Rapid battery recharge duration <100 min ▪ Recharger unit for two to three batteries ▪ Optional IV tubing lengths ▪ Flight approved (airworthy) ▪ Functions in hypo/hyperbaric environments ▪ Operating conditions for battlefield temperature ▪ (-10°C to 45°C) and humidity (5 to 95% rh) ▪ Fluid and blood products output temperature at least 38°C at ≥100 to 150ml/min (4°C starting temperature) ▪ Reusable warming device

List of warming devices available on the market.

- **Level A**: Evidence from multiple randomized trials or meta-analyses.
- **Level B**: Evidence from a single randomized trial or non-randomized studies.
- **Level C**: Expert opinion, case studies, or standards of care.

Abbreviations: √, mildly effective; √√, moderately effective; √√√, highly effective

Warming Device	FDA Approval	Flight Approved	Rewarming Efficacy >100mL/Min	Level	Reference	Comments
Belmont Buddy Lite	Yes	Yes	√	A	Bruells et al.[17] Kim et al.[18] Lehavi et al.[10] Milligan et al.[19] Weatherall et al.[20]	Higher administration rates will cause the cartridge to pop out of the locking block.
Thermal Angel	Yes	Yes	√	A	Weatherall et al.[21]	Higher administration rates drastically drop the end output temperature. At colder input temperatures, the Thermal Angel administration rate drops.
enFlow	Yes	Yes	√	A	Bruells et al.[17] Kim et al.[18] Lehavi et al.[10] Zoremba et al.[21]	Device performs best when working with warmer fluids, as cited in Kim et al. study. *****DEVICE RECALLED due to aluminum elution from warming cartridge*****
QinFlow Warrior	Yes	Yes	√√√	A	Lehavi et al.[10]	Performed the best in comparison to the other warmers with colder input temperatures.
QinFlow Warrior Lite	Yes	Yes	√√√	C	N/A Peered Research	Same warming cartridge as QinFlow Warrior.
MEQu M Warmer	No	Yes	√√√	A	Blakeman et al.[22] Weatherall et al.[20]	NATO approved, awaiting FDA approval, performed best in side-by-side comparison of the Buddy Lite, Buddy Liter, and Thermal Angel with packed red blood cells
Lifewarmer Quantum*	Yes	Yes	√√√	C	N/A Peered Research	Not currently peer reviewed. **SOCOM funded device.*

SECTION 3: TEMPERATURE MONITORING

Temperature Monitoring Devices

- Temperature sensing Foley
- (Forehead) temperature sensing 'dots'
- DataTherm(R)II Continuous Temperature Monitor - in the SOCOM Tribalco T-5 Cardiac Ki
- Propaq MD
  - Airworthiness approved

    - BATDOK (Battlefield Assisted Trauma Distributed Observation Kit) enabled
    - Several different options available for real-time temperature monitoring
- Philips Tempus Pro - Airworthiness approved
- Welch Allyn SureTemp - Airworthiness approved
- 3M Bair Hugger Temperature Monitoring System[23] - Portable device still under development, but may have applicability in the trauma setting

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APPENDIX B: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command-requested, unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

CRITICAL CARE AIR TRANSPORT CLINICAL PRACTICE GUIDELINE

THE I-STAT PORTABLE BLOOD ANALYZER IN AUSTERE LOCATIONS (CPG ID:47)

The goal of this clinical practice guideline (CPG) is to present the proper use and maintenance of use of the i-STAT portable blood analyzer, with a focus on the en-route care environment. The series is developed by the Center for Sustainment of Trauma and Readiness Skills, University of Cincinnati Medical Center.

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Major updates

1. The procedure for receiving a new shipment of cartridges has been added.
2. The method for correctly obtaining a blood specimen, to include criteria for specimen rejection, has been included.
3. An appendix for how to prepare a cartridge for analysis has been developed.
4. An appendix for running a control and an external simulator has been inserted.

Goal

This guideline outlines the expectations and instructions for maintenance, calibration, quality control, and use of the i-STAT portable blood analyzer. Updates include how to mitigate the negative impact of harsh environmental conditions found in deployment on the equipment and analyzer results.

Background

Point-of-care (POC) testing is defined as a pathology or laboratory test that is performed at the site of clinical interaction allowing immediate decision regarding treatment.[1] Because POC tests are performed in a non-laboratory setting, they are designed to be as simple as possible and produce reliable results when used by non-laboratory health-care professionals.[2] In this sense, POC testing is ideal for the En-Route Critical Care (ERCC) environment, however, austere ERCC conditions can affect the POC test results. One of most important environmental factors that medics must always be cognizant of are extremes in ambient temperature; exposure to extreme temperatures can render results inaccurate.

Critical Care Air Transport Teams (CCATTs) use the i-STAT (Abbott Point of Care, Princeton, NJ, USA) as their POC device (Figure 1).[3] CCATT must therefore understand how to use the equipment, be able to troubleshoot and calibrate the analyzer, and also provide quality assurance with controls and simulators (the function of controls and simulators will be defined below). In addition, teams must be aware of the specific drugs and environmental conditions that alter test accuracy. Finally, teams are also responsible for protecting POC testing equipment from the elements.

Figure 1. i-STAT Analyzer

The i-STAT analyzer can measure multiple different lab values: cardiac troponin I, electrolytes, blood gas, urea, creatinine, glucose, ionized calcium, and international normalized ratio (INR).

Test results from the i-STAT are generally available in 10 minutes or less. The results displayed on the screen depend on the type of cartridge inserted into the analyzer.

The cartridges that are typically stocked for use by CCATT are the CHEM8+, CG8+, EG7+, and CG4+. Cartridges are each loaded with a sample of the patient's blood and inserted into the bottom port of the analyzer for analysis.

The **CG8+ cartridge** (Figure 2) measures glucose, sodium, potassium, ionized calcium, hemoglobin, and hematocrit. The blue arrow just to the right of "CG8+" defines the fill mark when blood is loaded into the cartridge; this indicates the volume of blood necessary to perform the test.

The **EG7 cartridge** measures sodium, potassium, ionized calcium, hemoglobin, hematocrit, pH, $PaCO_2$, PaO_2, TCO_2, HCO_3, base excess, SO_2.

The **CHEM8+ cartridge** (Figure 3) measures creatinine, Blood Urea Nitrogen (BUN), glucose, ionized calcium, anion gap, TCO_2, chloride, potassium, and sodium. The fill mark is at the beginning of the blue segment.

The **CG4+ cartridge** measures lactate, pH, $PaCO_2$, PaO_2, TCO_2, HCO_3, base excess, SO_2.

The quality controls for the i-STAT system are simulators and controls. There are two types of simulators for the i-STAT: internal and external. Internal simulators are built into the analyzer and external simulators (Figure 4) must be inserted into the analyzer in the same port that receives the cartridge. Both types of simulators mimic the signals that a cartridge, loaded with blood, would send to the analyzer; simulators validate the analyzer. Controls are liquids that are injected into the cartridge (instead of blood); the cartridge is then inserted into the analyzer and run to validate the cartridge. CCATT members are tasked to perform these quality checks to ensure lab tests are accurate.

Figure 2. CG8+ cartridge.

Figure 3. CHEM8+ cartridge

Figure 4. External simulator

Procedure for Handling New Cartridge or Control Shipments

Cartridges must be kept refrigerated to maintain their integrity and reliability. Therefore, upon receipt, open the box marked "Refrigerate upon Arrival." Next, identify the card with the temperature strip attached and read it. Once it is exposed to room temperature the reading will begin to change. Follow instructions on card and if the reading is found to be unacceptable, contact technical support.

Record the temperature reading on the "Receipt of New Cartridges" Log.

If the temperature strip reading is acceptable, perform a test of one cartridge from each box with the liquid control; this validates the remaining cartridges within each box. If you receive multiple boxes with

the same cartridge lot number you only have to run the test once instead of running controls for each box. A similar procedure should be used for shipments of controls.

Storage: Procedures for Cartridges, Controls and the Analyzer

Cartridges: The main supply of cartridges should be kept refrigerated at 2—8°C (35—46°F). In this state, they may be used until the date shown on the cartridge pack or box. Do not allow the cartridges to freeze. Cartridges may also be stored at room temperature (18-30°C or 64-86°F) for the time frame defined on the cartridge box. For example, CG8+ cartridges may be stored at room temperature for up to 2 weeks; then they must be discarded. Cartridges should not be returned to the refrigerator once they have been warmed to room temperature, and they should not be exposed to temperatures above 30°C (86°F). If a cartridge is removed from the refrigerator, then the labeled expiration date should be crossed out and the temperature expiration date should be written on the cartridge package.

Controls: Blood gas, electrolyte, and chemistry controls should be stored at 2—8°C (35—46°F). They may also be stored at room temperature (18 to 30 °C or 64 to 86 °F), but only for up to 5 days.

Analyzer: The i-STAT analyzer (and accessories) should be stored in the hard plastic case provided in the allowance standard. The device should be protected from extremes of temperature as much as possible. The optimal operating temperature range is 16 to 30 ºC.

Electronic Simulator: Store at room temperature and protect contact pads from contamination by making sure the blue plastic cap (Figure 4) covers the contact pads when stored in its protective case after use.

Deployment Considerations

One challenge for POC testing in the deployed setting is keeping the equipment within the proper temperature range.

- Cartridges used for a mission may be placed in the CCATT refrigerator bag to avoid temperature exposures above 30°C (86°F). Another option is to hand carry the i-STAT cartridges rather than leave them in the gear set. Do not leave the i-STAT cartridges exposed to direct sunlight and maximize use of climate-controlled environments (e.g., flight-line vehicles) to moderate temperature extremes.
- Optimal operating temperature for the i-STAT analyzer is 16—30 ºC (61—86ºF). If the device is either too hot or too cold at power-up, the following error message will be displayed on the screen: Temperature Out of Range. For a cold device, find a warm area on the aircraft or truck or place the analyzer in your flight suit to warm up. When the device is too hot, rest it on top of an ice pack and protect it from getting wet with a piece of plastic or a Chux pad. Typically only 5 minutes is needed to reduce the temperature to an acceptable level. If an aircraft is pre-positioned with equipment to minimize response time for “wheels-up,” the i-STAT may become too hot and not function.
- If a cartridge is used beyond its temperature expiration date, or if a cartridge is used despite having been exposed to a temperature beyond 30°C (86°F), then annotate this on the 3899L (next to the lab result). It is left the provider’s discretion whether to use the results in clinical decisions.

Blood Sample Collection: Procedure for Arterial and Venous Draws

For cartridge testing of blood gases, electrolytes, chemistries, and hematocrits, draw the patient's blood as described below.

Blood Draw

Completely fill a plain syringe, blood gas heparinized syringe (in the CCATT allowance standard), or a syringe with the minimum volume of heparin to prevent clotting (10 U/mL of blood). Mix a heparinized syringe by rolling it between the palms for at least 5 seconds in two directions, then invert the syringe repeatedly for at least 5 seconds. For best results, test the blood immediately. For samples measuring pH, PCO_2, PO_2, TCO^2, and ionized calcium, sample processing within 10 minutes of blood draw is acceptable; other analytes can be processed within 30 minutes of blood draw if a heparinized syringe was used. If a tourniquet is used for a venous stick, do not leave it on for more than 1 minute; do not draw blood proximal to an IV site.

Criteria for Specimen Rejection

1. There is evidence of specimen clotting.
2. Specimens were collected in vacuum tubes with anticoagulants other than lithium or sodium heparin.
3. Syringe for pH, PCO_2, PO_2, or TCO_2 has air bubbles in sample. An air bubble stuck only on the plunger will not affect the results.

Precautions: Avoid the Following Circumstances

- Drawing a specimen from an arm with an IV.
- Stasis (tourniquet left on longer than 1 minute before venipuncture).
- Extra muscle activity (fist pumping).
- Hemolysis (alcohol left over puncture site or a traumatic draw).
- Time delays before filling cartridge.
- Exposing the sample to air when measuring pH, PCO_2, PO_2, or TCO_2.

Cartridge Preparation for Loading Blood Sample

- Prior to using a cartridge, it must be removed from refrigerated storage and kept at room temperature in its protective pouch for at least 5 minutes.
- An entire box of cartridges must be kept at room temperature for 1 hour before a cartridge from the box can be used. Avoid condensation from forming on a cold cartridge as it may prevent proper contact with the analyzer.
- The process for loading the cartridge with blood is detailed in Appendix A.

Quality Assurance

Electronic Simulators

- The i-STAT analyzer has both an internal and external simulator to perform quality checks. Simulators mimic the signals that would be sent from a cartridge charged with blood to validate whether the analyzer is functioning properly.
- The analyzer runs a comprehensive check with the internal simulator each time a patient's blood sample is tested.
- The external simulator needs to be plugged into the analyzer where a cartridge is attached. **The external electronic simulator should be run when indicated by the i-STAT device or every 8 hours while in use. If mission is over 8 hours, it is recommended to run the external simulator prior to the mission and then again if the mission is over 8 hours.** The testing procedure takes approximately 120 seconds. Appendix B details how to run an external simulator.
- **Any analyzer that fails an electronic simulator check twice (internal or external) should be removed from service and turned in for maintenance.**
- The i-STAT analyzer is programmed to lock out if the internal or external simulator does not pass the quality control.

Liquid Controls

- Liquid controls, which are injected into cartridges, verify the cartridges are producing accurate results and should be used each time a new batch of cartridges is opened. Controls may also be ran if there is concern that a group of cartridges was placed in an environment outside of the storage guidelines – for example, in a place with an ambient temperature above 30°C (86°F). In particular, Level 1, 2, and 3 controls for blood gas/electrolyte/metabolite cartridges are formulated solutions that represent 3 clinically relevant levels of known pH and with known concentrations of sodium, potassium, chloride, ionized calcium, PCO_2, PO_2, TCO_2, glucose, lactate, BUN, and creatinine. Level 1 and 3 controls are typically stocked for deployed CCATTs.

  Note: *Hemoglobin is validated with another type of control (RNA Medical® Hematocrit Calibration Verification) that is not typically stocked for CCATTs.*
- Liquid controls do not need to be run if cartridges are obtained from a military treatment facility (MTF) lab that complies with this Clinical Practice Guideline (CPG). One should not assume, however, that the MTF is running controls with their cartridges.
- Consult the manufacturer's documentation if you plan to use cartridges not listed in this CPG because you will need to obtain the proper controls and run them prior to use, as well as update the software through your local Biomedical Equipment shop.
- Appendix C describes how to run controls.

Internal quality check

If stars (***) are displayed instead of a lab result, it means that a test failed the internal quality checks. All other reported results are accurate as long as the sample integrity is not in question. If this occurs, one can remix the tube of blood and repeat the test using a new cartridge. If the result fails to display

again, draw a fresh blood sample and repeat the test. If the result is still not displayed, consider turning the device in for maintenance or call technical support.

Medications That Can Affect i-Stat Results

- For patients administered propofol or thiopental sodium, i-STAT recommends the use of CG4+, CG8+, EG6+, and EG7+ cartridges, which are free from clinically significant interference at all relevant therapeutic doses. i-STAT does not recommend the use of EC8+ cartridges for patients receiving propofol or thiopental sodium.
- Acetaminophen and creatine can increase creatinine measurements by 0.20—0.25 mg/dl.

Documentation

- Document that liquid controls were used to verify a new box of cartridges on a log or on the box containing the cartridges.
- Document in the 3899L *Patient Movement Record Enroute Critical Care* form if a used cartridge was not stored or quality checked correctly: (1) if controls were not run for a new box of cartridges, and the cartridge was used, (2) if an expired cartridge was used, and (3) if a cartridge was used but was placed in an environment not consistent with proper storage (e.g., temperature above 30°C/86°F).

Practical Advice to Optimize Use of the i-STAT in the Deployed Setting

- Seek arrangements permitting you to obtain extra i-STAT cartridges from MTFs if your supply chain is limited, however, they are in no way obligated to do so. If the deployed location does not have a refrigerator, it may also be possible to drop off your main store of cartridges at the MTF for temperature-controlled storage and the running of controls. Obtaining cartridges from an MTF laboratory will eliminate the need to monitor storage temperature. Some laboratories, however, do not use i-STAT, so they may only be able to store your controls and cartridges; you will still be responsible for ensuring that the liquid controls are completed.
- Consider comparing the i-STAT results with MTF derived values:
- When circumstances permit, teams are advised to perform one i-STAT test while MTF personnel simultaneously measure the same parameters on a patient.
- If the results are similar, it adds some certainty to the accuracy of the i-STAT and cartridge lot currently in use.
- Discordant results suggest a problem with the analyzer or cartridges and should prompt further investigation; the team should consider turning the device in for maintenance.
- **There is no scientific basis for determining the direction and magnitude of difference between the i-STAT and MTF lab and then using that value as a correction factor to adjust results.** There is no reason to believe that the difference in values will be in the same direction or of the same magnitude for subsequent measurements.

Software Updates

- The sensors in the i-STAT cartridges are standardized against plasma methods used by major laboratory systems. The i-STAT is programed with CLEW software, the coefficients of which are determined by comparing the i-STAT results to this standardization process. Due to possible changes in the manufacturing process, the CLEW software requires recalibration to avoid drift from the lab values produced by the major laboratory systems. This is why software updates are mandated twice a year.
- The i-STAT analyzer will not function with expired software. A warning will appear on the screen 15 days before the software expires.
- The i-STAT can be updated using a desktop computer or another i-STAT with current software (Appendix D).
  - This method may be problematic for deployed personnel due to regulations preventing attachment of devices to government computers.
  - If this method is approved by command, the software can be downloaded from the internet.
  - Navigate directly to http://www.abbottpointofcare.com/Customer-Info-Center.aspx.
  - Registration using a military email address will be required.
- The i-STAT can be updated using a second i-STAT with current software. This method may be easier in the deployed setting since it avoids the issue of having to attach a device to a government computer and does not require the internet. The second device may be obtained from another CCATT or an MTF. A step-by-step instruction set is presented in Appendix D.
- **It is recommended that deployed personnel coordinate with a nearby MTF or contact a servicing biomedical maintenance shop as needed for assistance with software updates.**

Visual Overview of Properly Stored Equipment

6630015267377 I-STAT KIT FOR CCATTS

Abbott Point of Care Customer Support

- Assistance from Abbott website.
  1. Go to https://www.pointofcare.abbott/us/en/home.
  2. Choose Support from the horizontal menu at the top of the page.
  3. You will need to create an account and/or log in.
- Email techsvc@apoc.abbott.com
- Call 1-800-284-0702.

Fixed (Expected Clinical Proficiency)

CCATT members are expected to be able to perform the following tasks:

1. Receive cartridge and control shipments.
2. Obtain blood specimens correctly and identify inadequate samples.
3. Perform quality controls for the i-STAT system.
4. Process blood samples.
5. Store the equipment correctly.
6. Mitigate environmental conditions (such as temperature) that can affect equipment and results.

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Appendix A: Procedure for Preparing and Running an i-STAT Sample

Step 1: Verify the type of cartridge to use and check the expiration date. Ensure the cartridge is at room temperature.

Step 2: Power on the analyzer (bottom right button). Select option 2 to run a new lab test. You will be prompted to enter you user ID (use the last 4 digits of your SSN); hit ENTER. You will have to reenter your ID for confirmation. Then enter patient ID (last 4 of the patient's SSN, if available); hit enter. Repeat for confirmation.

Step 3: Scan the barcode on the cartridge packaging, (Figure A1); this defines for the analyzer which cartridge type is being run and it also checks the expiration date. Simply press and hold the SCAN button and point at the bar code on the cartridge packaging (Figure A1). The screen will then instruct you to insert a cartridge. You are ready to prepare the cartridge.

Step 4: Collect the blood sample. (Method is defined in *Blood Sample Collection: Procedure for Arterial and Venous Draw*).

Step 5: Tear open cartridge package and remove the cartridge, only touching edges (Figure A2). Touching the metal contacts on the top of the cartridge may affect results.

Step 6: Before injecting blood into the sample well, ensure there are no bubbles in the sample (these can affect CO_2 results).

Step 7: Fill cartridge to the appropriate fill line (Figure A3). The Chem8+ and CG4+ cartridges have fill lines that are at the beginning of the blue segment (Figure 3); CG7 and CG8+ cartridges have a blue arrow (Figure 2). Use the best flat surface on the aircraft for injection. The sample well should be about halfway full

Step 8: Seal the cartridge's sample well by rotating the well's cover and snapping it closed (Figure A4) ***DO NOT press directly over the sample port****, as blood may be pressurized, potentially bursting/failing the cartridge* (Figure A5). Apply pressure only at the edge of cap when sealing

Step 9: Insert the cartridge into the analyzer; results will display in 2–4 minutes. Toggle arrow buttons to view different pages of results.

Figure A1. Scanning cartridge bar code

Figure A2. Proper cartridge handling

Figure A3 Loading cartridge sample well with blood

Figure A4. Rotating cover

Figure A5. Sealing the cartridge

Appendix B: Procedure for Running the External Simulator

The external simulator (Figure 4) mimics the signals that would be sent from a cartridge to validate whether the analyzer is functioning properly. In particular, it simulates two levels of electrical signals that stress the analyzer's signal detection function both below and above measurement ranges. It provides an independent check on the ability of the analyzer to take accurate and sensitive measurements of voltage, current, and resistance from the cartridge. An analyzer will PASS or FAIL this test depending on whether or not it measures these signals within specified limits. ***The electronic simulator will fail if high relative humidity interferes with the measurements.***

If the analyzer and simulator have been stored separately in areas where the ambient temperature differs by more than 3°C (5°F), allow the simulator and analyzer to stand in the same place for 30 minutes before inserting the simulator into the analyzer. ***Handle the simulator as little as possible to maintain its thermal uniformity and stability.***

Procedure for running the external simulator:

Step 1: Power on the analyzer (bottom right button).

Step 2: Ignore options 1 or 2 that appear on the screen and press the Menu button, then select Option 3 for Quality Test.

Step 3: A sub-menu appears; select Option 4 for Simulator.

Step 4: Scan the external simulator's barcode into the analyzer by pressing and holding the Scan button. Another option is to manually enter the number associated with the bar code.

Step 5: Insert the external simulator into the same port where cartridges are inserted with the "I" facing up (Figure 4); do not touch the contact pads. Cartridge Locked will be displayed, indicating that the simulator should NOT be removed. An attempt to forcibly remove the simulator during this cycle may damage the analyzer. It will take about 60 seconds for the test to run. PASS or FAIL will show on the screen.

- If PASS is displayed, remove the simulator ONLY after the *Cartridge Locked* message disappears from the screen.
- If FAIL is displayed, repeat the procedure with the same external simulator. If PASS displays after the second attempt, the analyzer may be used. If FAIL is displayed, repeat the procedure with a second analyzer; the analyzer may be used if PASS is displayed. If FAIL is displayed, repeat the procedure with the same, second simulator. The analyzer may be used if PASS is displayed. For a second FAIL display (using a second external simulator), the analyzer cannot be used and should be turned over to maintenance.

Appendix C: Procedure for Running Controls

Level 1, 2, and 3 controls for blood gas/electrolyte/metabolite cartridges are formulated at three clinically relevant levels with known pH and with known concentrations of sodium, potassium, chloride, ionized calcium, PCO_2, PO_2, TCO_2, glucose, lactate, BUN/urea, and creatinine. Level 1 and 3 controls are typical stocked for deployed CCATTs.

Verifying hematocrit measurements, however, requires another type of control: the RNA Medical® Hematocrit Calibration Verification Controls. Levels 1, 3, and 5 should be run on the following cartridges: E3+, EC4+, 6+, EC8+, EG6+, EG7+, CG8+, and CHEM8+. This control is NOT typically stocked for CCATTs downrange.

Liquid controls used in a cartridge that measures oxygen concentration must stand at room temperature for a minimum of 4 hours before use; controls for other analytes only need to equilibrate at room temperature for 30 minutes. The analyzer should also stand at room temperature for 30 minutes.

Procedure for running a control:

Step 1: Put on gloves.

Step 2: Press the On button.

Step 3: Press the Menu key; then press 3 to select Quality Tests.

Step 4: Press 1 to select Control.

Step 5: You will be prompted to scan or manually enter the Operator ID and Control Number. It may be convenient to enter 1 as the operator ID for a level 1 control and 3 for a level 3 control; this may make it easier when comparing the results to the *Value Assignment Sheet*.

Step 6: Press Scan to scan the barcode cartridge lot number.

Figure C1. Level 1 and 3 ampules

Step 7: Remove the cartridge from the package, taking care to handle it only along the edges, otherwise the results may be affected. Place the cartridge on a flat surface.

Step 8: Shake the control ampule (Figure C1) hard 15–20 times (for at least 10 seconds) and then tap the ampule to restore the liquid to the bottom of the ampule.

Step 9: Open the ampule by snapping off the tip. Protect fingers with gauze or use an ampule breaker.

Step 10: Immediately transfer control to syringe as follows: use a clean 3 mL syringe. Replace attached needle with a 19-gauge blunt tip needle, if available, for safety. Avoid drawing air bubbles into the syringe.

Step 11: Immediately expel 3 drops of control on a pad/gauze and then fill cartridge to the fill line and seal the cartridge (see Appendix A for details). Aqueous-based solutions such as controls do not have the buffering capabilities of whole blood; therefore, once opened, they must be immediately transferred to the cartridge (unlike with a patient's sample).

Step 12: Do not use the solution left in a syringe or ampule for additional testing of cartridges that contain sensors for ionized calcium, pH, PCO_2, or PO_2; a new ampule must be used.

Step 13: Insert cartridge into the analyzer; do not remove until *Do Not Remove Cartridge – Cartridge Locked* message is gone.

Step 14: Control Evaluation. Compare the results to the *Value Assignment Sheet*. If any result is out of range, repeat the control testing with a fresh ampule and syringe. If any result is still out or range, do not use any of the cartridges from this lot. *Value Assignment Sheets* are obtained from the Abbott Point of Care website (http://www.abbottpointofcare.com/Customer-Info-Center/Value-Assignment-Sheets.aspx). You will need to know the CLEW version on your device and the lot number of the control solution you used.

Note: *Correction of PO2 value is required when running controls at locations more than 1000 feet above sea level. Use the barometric pressure reading from the i-STAT status screen and the following formulas:*

- For PO2 values < 150 mmHg: for every decrease of 15 mmHg in barometric pressure from 760 mmHg, add 1 mmHg to observed PO_2 value.
- For PO2 values > 150 mmHg for every decrease of 35 mmHg in barometric pressure from 760 mmHg, add 1 mmHg to observed PO_2 value.

Appendix D: Updating i-STAT CLEW Software using another i-STAT Device

We recommend that biomedical maintenance preform this procedure, if possible.

The sensors in the i-STAT cartridges are standardized against plasma methods used by major laboratory systems. The i-STAT is programed with CLEW software, the coefficients of which are determined by this standardization process. Due to possible changes in the manufacturing process, the CLEW software requires recalibration to avoid drift from major laboratory systems. This is why software updates are mandated to occur twice a year.

Step 1: Be certain both i-STAT devices have at least 7.5 volts of battery power remaining.

Step 2: Turn the power off on the receiving device. The power on the receiving device will remain off for the entire procedure.

Step 3: Place both devices on a flat surface with the infrared windows aligned approximately 1 foot apart.

Step 4: Turn on the sending device, press Menu, and select option 7 for Utility.

Step 5: Press ENT when prompted for a password.

Step 6: In the utility menu press 1 for Send Software.

Step 7: Press 1 for JAMS###/A##.
***Note**: the numbers have been replaced with # in this example; they will change with each software update.*

Step 8: When the sending device displays *Waiting to Send*, start sliding the receiving device towards the sending device with the infrared windows aligned until the sending device displays *Sending*. Do not lift it off the flat surface.

Step 9: Wait until the sending device returns to the utility menu and displays *Last send successful* before moving devices.

Step 10: Run the external electronic simulator on the receiving device to verify successful software update.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Infection Prevention in Combat-related Injuries (CPG ID:24)

Provides rationale and guidance for the prevention of infection after combat-related injuries.

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SUMMARY OF CHANGES

1. New references have been added based on new data from the *Trauma Infectious Disease Outcomes Study* supporting previous recommendations to limit gram negative therapy for prophylaxis of extremity wounds.
2. The duration of antibiotics for open fractures has been curtailed to only the first 24 hours and re-dosing with subsequent irrigation and debridement.
3. Clarification had been added to describe the cohorting of patients. Long term patients (>72 hours) had been clarified to mean host nation patients; short term (<72 hours) has been clarified to mean U.S. personnel.
4. Antimicrobial stewardship recommendations have been expanded to include the recommendation for facilities responsible for trauma care to monitor adherence to antimicrobial prophylaxis regimens.
5. Reach back information has been updated to include the ADvanced VIrtual Support for OpeRational forces (AD.VI.S.OR) network and to the updated Army Infection Control email address.
6. Vancomycin dosing has been updated to reflect weight-based dosing and clindamycin dosing has been simplified.
7. A tetanus prophylaxis appendix has been added.

BACKGROUND

Infection has been a complication of war wounds throughout history. Infection prevention and control techniques in combat injuries, first widely practiced by Florence Nightingale in the Crimean War, have significantly advanced the care of the injured patient. The battlefield poses unique challenges in care for combat-related injuries. These include multiple patient transfers between hospitals and teams, the austere environment of theater medical care, and the difficulties arising during long distance aeromedical evacuation.[1-3] Infections are frequent complications of combat casualties and are characterized by multi-drug resistant organisms (MDROs). MDROs are predominantly acquired through nosocomial transmission in the chain of tactical combat casualty care.[4-5] These MDROs have been shown to originate from colonization of host nation patients which sets the stage for a more complicated healthcare environment. Infection prevention and control practices must be able to effectively adapt to these challenges and support the prevention and spread of infection by implementation of early and repetitive surgical wound care.

NOTE: *Related Clinical Practice Guidelines (CPGs) published by the Joint Trauma System (JTS): Ventilator-Associated Pneumonia; Blunt Abdominal Trauma Splenectomy Post-Splenectomy Vaccination; Invasive Fungal Infection in War Wounds; War Wounds: Debridement and Irrigation; Acute Traumatic Wound Management in the Prolonged Field Care Setting. CPGs are posted at https://jts.health.mil/index.cfm/PI_CPGs/cpgs.*

STANDARD PRECAUTIONS

These standard precautions apply to all patients, regardless of suspected or confirmed infectious status. The application of standard precautions during patient care is determined by the nature of the interaction between the healthcare worker and the patient, in addition to the extent of anticipated blood, body fluid or pathogen exposure.[6] These include but are not limited to the following.

- **Hand washing**: The World Health Organization's "five moments of hand hygiene" include:
  1. use of soap and water or alcohol-based sanitizer before patient contact;
  2. before aseptic tasks;
  3. after body fluid exposure risk;
  4. after patient contact; and
  5. after contact with patient surroundings, even if gloves were worn.[7]

  The gold standard to ensure adherence is direct observation which allows for immediate corrective feedback.[8]
- **Gloves**: Use to prevent contamination of hands when anticipating direct contact with non-intact skin, mucous membranes and blood or body fluids (e.g., dressing changes, starting IVs).
- **Gowns**: Isolation gowns are specified by standard and transmission-based precautions to protect the healthcare worker's arms and exposed body areas and prevent contamination of clothing with blood, body fluids, and other potentially infectious material (e.g., changing dressings or open wounds). Gowns are always used in conjunction with gloves.
- **Masks**: Masks protect healthcare workers from contact with infectious material originating from patients. They are also used to protect the patient when performing sterile techniques to protect patients from exposure to infectious agents carried in a healthcare workers' mouth or nose.
- **Goggles or Face Shields**: Use is based on anticipated exposure. Personal eyeglasses and contact lenses are not considered adequate eye protection.

Emphasize basic infection prevention control efforts (for example, hand hygiene, cohorting, transmission-based isolation) to prevent spread from other hospitalized patients and to decrease antibiotic pressure selecting for resistant organisms.

TRANSMISSION-BASED PRECAUTIONS

Transmission-based precautions covers droplets, airborne and physical contact. For this CPG, we will only describe the use of contact precautions for epidemiologically important organisms to include Clostridium difficile (C. difficile).

- **Cohorting**: Cluster host nation patients (who are not eligible to evacuate from theater) and U.S. and coalition patients (who are eligible for evacuation from theater) and separate when possible to reduce the risk of cross-contamination with MDROs.
- **Contact Precautions**: Gloves and gowns should be worn with all patients suspected or known to have MDRO colonization or infection with C. difficile- infection (CDI) and immediately placed

into contact precautions.[8] Refer to Appendix A of the 2007 Isolation Guidelines published by the Centers for Disease Control and Prevention (CDC) for a list of all diseases requiring contact precautions.[6]

NOTE: *U.S. personnel with skin and soft tissue infections presenting with abscess or furuncles should be assumed to have community-associated Methicillin-Resistant Staphylococcus Aureus (MRSA).*

- **Skin care**: Intensive care unit (ICU) patients should undergo daily bathing with topical chlorhexidine gluconate (CHG). CHG-impregnated wipes are available commercially. CHG has broad activity against gram-positive and gram-negative bacteria, facultative anaerobes and aerobes. Daily bathing of ICU patients has shown a reduction of infections with vancomycin-resistant enterococci (VRE) and methicillin-resistant staphylococcus aureus (MRSA). Daily bathing with CHG washcloths significantly reduces the risk of acquisition of MDROs.[9-11] See Appendix E: Antiseptic Body Cleaning.[11]

ANTIMICROBIAL STEWARDSHIP

- Antimicrobial drug usage contributes to the development of multidrug-resistant organisms. Use of overly broad antibiotics for combat trauma prophylaxis has resulted in an increased risk of MDRO infection without improvement in long-term clinical outcomes such as number of surgical procedures, length of hospitalization, or osteomyelitis.[12,13]
- All facilities should avoid unnecessary empiric use of broad spectrum antibiotics.
- When available, use local antibiogram to guide empiric therapy.
- Limit duration of antibiotic therapy. Several well-controlled studies have shown benefit to shorter courses of antibiotic therapy for common infectious problems (for example, pneumonia.). Prolonged duration of prophylaxis has not been shown to decrease long term rates of infections in retrospective study of 1,044 patients with combat-related open fractures.[12] The shortest course of post-injury antimicrobial therapy should be used.
- Appendix B: Post-Injury Antimicrobial Agent Selection and Duration describes antimicrobial prophylaxis regimens and proposed durations for combat wounded personnel.

ADHERENCE TO ANTIMICROBIAL PROPHYLAXIS

All facilities responsible for trauma care should monitor adherence to antimicrobial prophylaxis regimens.[14] Special situation: care of combat injured secondary to suicide bomber/blast injury

Blast injuries, especially those related to suicide bomber attacks, present a unique bloodborne pathogen risk if an impaled body part is introduced into the trauma patient. There have been reported cases of Hepatitis B virus (HBV)-positive impaled bone fragments recovered from suicide bomber victims in Israel.[15,16] This prompted the Israeli Ministry to provide post-exposure HBV vaccination as a practice. Since the initiation of the vaccine, HBV impaled fragments have been reported but no disease transmission.[17]

Prior to deployment, U.S. forces are required to receive a three-dose vaccine series, but 5-14% of vaccinated patients fail to achieve immunity (anti HBs <10 mlU/ml) which places them at increased risk

of transmission.[18,19] Thus we recommend attempting to verify anti-HBV status in those who are combat injured secondary to a suicide bomber and provide HBV immunoglobulin (HBIG) and HBV vaccine for those incompletely vaccinated with unknown titers or anti-HBs<10 mlU/ml. Recombinant Hepatitis B vaccine may be considered in those who have failed to respond to conventional Hepatitis B vaccine.

The risk of transmission for human immunodeficiency virus (HIV) is considered very low after blast injury and generally warrants no action.[17] However, in the case of penetrating blast injury in a highly endemic region, expert teleconsultation should be obtained to discuss case specifics. Specific recommendations can be obtained via email (usarmy.jbsa.medcom-rhc-c.list.amedd-ic-consult@health.mil) or the AD.VI.S.OR hotline found at https://prolongedfieldcare.org/telemed-resources-for-us-mil/ or with infection prevention or infectious disease consultants (usarmy.jbsa.medcom-rhc-c.list.amedd-ic-consult@health.mil) or with infectious disease consultants through the AD.VI.S.OR hotline. Hepatitis C (HCV) prophylaxis is not recommended, but testing can be considered in penetrating blast injury at the time of injury and at two, four, and six months.[20]

- **Healthcare Bloodborne Pathogen Exposure**: Staff caring for patients with combat wounds are at risk for blood borne pathogens (HBV, HIV and HCV).[20] At risk activities include security personnel searching patients (for example, patting down patients who are injection drug users, needle sticks, break in surgical technique and blood splatters to non-intact skin, eyes or mucosa).
- **Source testing should be obtained for HBV, HIV and HCV**: Testing for HBV and HIV should be obtained at time of exposure and up to six months post-exposure.[21] There is no post-exposure treatment for HCV, although excellent and well-tolerated regimens to cure HCV do exist for patients who become infected.
    - **For HBV**, treatment is based on the source's HBV surface antigen (HBsAg) status and the exposed patient's vaccine completion and post-vaccine titer (anti-HBs >10 mlU/ml. Refer to the *2018 CDC Prevention of Hepatitis B virus infection in the United States: Recommendations of the Advisory Committee on Immunization Practices: A summary of the MMWR report*.[22]
    - **For high risk HIV exposure**, 28 days of post-exposure prophylaxis with antiretroviral therapy should be administered within 1-2 hours but no later than 72 hours post-exposure. Refer to Updated *U.S. Public Health Service guidelines for the management of occupational exposures to HIV and recommendations for post-exposure prophylaxis*.[21]

CARE OF COMBAT-INJURED PERSONNEL BASED ON ROLE OF CARE

See Appendix A: Recommendations to Prevent Infections Associated with Combat-related Injuries based on role of care.

- Infection prevention and control or antimicrobial utilization questions can be fielded through usarmy.jbsa.medcom-rhc-c.list.amedd-ic-consult@health.mil.
- Ideally, Role 2 and 3 facilities should have a designated Infection Prevention and Control Officer (IPCO) as an additional duty or a full-time position if supported by manning levels. The U.S. Army holds an Infection Control in the Deployed Setting course open to all branches. Army Training Requirements and Resource System catalogs the course as 6A-F22 and U.S. Central Command requires and funds the course for Role 3 IPCOs.

- All facilities responsible for trauma care should monitor adherence to antimicrobial prophylaxis regimens as listed in the JTS guidelines for infection prevention after combat-related injuries and present rates to providers regularly. Rates should include adherence to recommended agents and duration of therapy.
- Ideally, Role 3 facilities should have a designated antimicrobial stewardship officer as an additional duty if supported by manning levels. Proposed antimicrobial stewardship measures should be discussed with an antimicrobial stewardship expert prior to implementation.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

The population of interest are all trauma patients with penetrating injury or diagnosis of open wound (includes open fracture or joint).

INTENT (EXPECTED OUTCOMES)

1. All patients in the population of interest receive the preferred or alternate antibiotic, or reason for different choice is documented.
2. All patients in population of interest have antibiotic administered within 3 hours of injury.
3. All patients in population of interest have a duration of prophylactic antibiotic use less than 72 hours, or documentation of reason for extended use.
4. All patients in population of interest admitted to the ICU have daily antiseptic body cleaning (for example, Sage, Chlorhexadine).

PERFORMANCE/ADHERENCE MEASURES

1. Number and percentage of patients in the population of interest who receive the preferred or alternate antibiotic.
2. Number and percentage of patients in the population of interest who receive other antibiotics (or and reason for different choice of antibiotics is documented).
3. Number and percentage of patients in the population of interest who have an antibiotic administered within three hours of injury.
4. Number and percentage of patients in the population of interest who have a duration of prophylactic antibiotic use less than 72 hours or documentation of reason for extended use.
5. Number and percentage of patients in the population of interest admitted to the ICU that have antiseptic body cleaning daily.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The pervious sections constitute the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The JTS Chief, JTS Program Manager, and the JTS PI Branch will perform the system review and data analysis.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: RECOMMENDATIONS TO PREVENT INFECTIONS LINKED TO COMBAT-RELATED INJURIES

Recommendations to prevent infections associated with combat-related injuries based on role of care. *Criteria for allowing retained fragments to remain behind: entry/exit wounds < 2 cm; no bone, joint, vascular, body cavity involvement; no high risk etiology (for example, mine); no obvious infection; assessable by x-ray.*

Table 1. Recommendations to Prevent Infections Linked to Combat-Related Injuries

Common Surgical Diagnoses	Care Category	Recommendations
Role 1 (Prehospital)	Initial care in the field	• Bandage wounds with sterile dressings (avoid pressure over eye wounds) • Stabilize fractures • Transfer to surgical support as soon as feasible
	Post-injury antimicrobials	• Provide single dose point of injury antimicrobials (Appendix B) if evacuation is delayed or expected to be delayed
Role 1 and Role 2 without surgical support (lla)	Post-injury antimicrobials	• Provide intravenous antimicrobials for open wounds (Appendix B) within 3 hours of injury. • Provide tetanus toxoid and immune globulin as appropriate (see Appendix C). • Gram negative coverage with aminoglycoside or fluoroquinolone not recommended. • Addition of penicillin to prevent clostridial gangrene or streptococcal infection is not recommended. • Re-dose antimicrobials if large volume blood product resuscitation. • Use only topical antimicrobials for burns.
	Debridement and irrigation	• Irrigate minor wounds to remove gross contamination with normal saline, sterile, or potable water without additives. • Debridement and irrigation of large wounds should be done at a surgical facility (Role 2b or 3). • Do not attempt to remove retained deep soft tissue fragments meeting criteria listed above. • Provide cefazolin 2 gm IV x 1 dose. • Refer to the *JTS War Wounds: Debridement and Irrigation CPG*.
Role 2 with surgical support and Role 3	Post Injury Antimicrobials	• Provide intravenous antimicrobials (Appendix B), within 3 hours of injury. • Provide tetanus toxoid and immune globulin as appropriate (Appendix C). • Re-dose Cefazolin with each debridement until bone has soft tissue coverage (Appendix B). • Gram negative coverage with aminoglycoside or fluoroquinolone not recommended. • Addition of penicillin to prevent clostridial gangrene or streptococcal infection is not recommended. • Re-dose antimicrobials if large volume blood product resuscitation. • Use only topical antimicrobials for burns. • Refer to the *JTS Invasive Fungal Infection CPG* for dismounted blast injuries, high amputations, and cases of recurring necrosis on staged debridements.

Common Surgical Diagnoses	Care Category	Recommendations
		• Provide post splenectomy immunizations if indicated. (See the *JTS Blunt Abdominal Trauma, Splenectomy, and Post-splenectomy Vaccination CPG*.)
	Debridement and irrigation	• Refer to the *JTS War Wounds: Debridement and Irrigation CPG*. • Antimicrobial beads pouches, or topical powder may be used. • Do not attempt to remove retained deep soft tissue fragments if criteria above are met. • Do not obtain cultures unless infection is suspected. • Do not attempt primary wound closure (except for dura and face).
	Other Surgical Irrigation	• N/A
Role 4	Post-injury antimicrobials	• Re-dose Cefazolin for 24 hours with each subsequent washout involving exposed bone. • Antimicrobial beads or pouches may be used. • Refer to the *JTS Invasive Fungal Infection CPG* for dismounted blast injuries, high amputations, and cases of recurring necrosis on staged debridements. • Provide post splenectomy immunizations if not documented. (See the *JTS Blunt Abdominal Trauma, Splenectomy, and Post-splenectomy Vaccination CPG*.)
	Debridement and irrigation	• Refer to the *JTS War Wounds: Debridement and Irrigation CPG*. • Do not attempt to remove retained deep soft tissue fragments if criteria above are met. • Do not obtain cultures unless infection is suspected. • Wounds should not be closed until 3-5 d post-injury when wound is clean and all devitalized tissue is removed.
	Other surgical management	• N/A

APPENDIX B : POST-INJURY ANTIMICROBIAL AGENT SELECTION & DURATION

Post-injury antimicrobial agent selection and duration based upon injury pattern.

Table 1. Post-Injury Antimicrobial Agent Selection and Duration

Injury	Preferred Agent(s)	Alternate Agent(s)	Duration
Extremity Wounds (Includes Skin, Soft Tissue, and Bone)			
Skin, soft tissue, no open fractures	Cefazolin, 2 gm IV q6-8h†‡	Clindamycin (450 mg PO TID or 900 mg IV q8h)	24 hours
Skin, soft tissue, with open fractures, exposed bone, or open joints	Cefazolin, 2 gm IV q6-8h†‡ §	Clindamycin 900 mg IV q8h	24 hours initially and repeat with each subsequent I&D until soft tissue coverage.
Thoracic Wounds			
Penetrating chest injury without esophageal disruption	Cefazolin, 2 gm IV q6-8h†‡	Clindamycin (450 mg PO TID or 900 mg IV q8h)	1 day
Penetrating chest injury with esophageal disruption	Cefazolin, 2 gm IV q6-8h†‡ PLUS metronidazole 500 mg IV q8-12h	Ertapenem 1 gm IV x 1 dose, OR Moxifloxacin 400 mg IV x 1 dose	Stop 24 hours after definitive closure
Abdominal Wounds			
Penetrating abdominal injury with suspected/known hollow viscus injury and soilage; may apply to rectal/perineal injuries as well	Cefazolin, 2 gm IV q6-8h†‡ PLUS metronidazole 500 mg IV q8-12h	Ertapenem 1 gm IV x 1 dose, OR Moxifloxacin 400 mg IV x 1 dose	Stop 24 hours after control of contamination
Maxillofacial And Neck Wounds			
Open maxillofacial fractures, or maxillofacial fractures with foreign body or fixation device	Cefazolin, 2 gm IV q6-8h†‡	Clindamycin 900 mg IV q8h	24 hours
Central Nervous System Wounds			
Penetrating brain injury	Cefazolin 2 gm IV q6-8h. †‡Consider adding metronidazole 500 mg IV q8-12h if gross contamination with organic debris	Cetriaxone 2 mg IV q24h. Consider adding metronidazole 500 mg IV q8-12h if gross contamination with organic debris. For patients with a history of anaphylaxis or allergies to cephalosporins, vacomycin 15-20mg/kg IV q 8-12h PLUS ciprofloxacin 400 mg IV q8-12h	5 days or until CSF leak is closed, whichever is longer

Injury	Preferred Agent(s)	Alternate Agent(s)	Duration
Penetrating spinal cord injury	Cefazolin, 2 gm IV q6-8h.†‡ ADD metronidazole 500 mg IV q8-12h if abdominal cavity is involved	As above. ADD metronidazole 500 mg IV q8-12h if abdominal cavity is involved	
Eye Wounds			
Eye injury, burn or abrasion	Topical: Erythromycin or Bacitracin ophthalmic ointment QID and PRN for symptomatic relief. Systemic: No systemic treatment required	Fluoroquinolone 1 drop QID	Until epithelium healed (no fluoroescein staining)
Eye injury penetrating	Levofloxacin 750 mg IV/PO once daily + vancomycin 15-20 mg/kg IV q8-12h. Prior to primary repair, no topical agents should be used unless directed by ophthalmology	Moxifloxacin 400 mg IV/PO once daily	7 days or until evaluated by an ophthalmologist
Burns			
Superficial burns	Topical antimicrobials with daily dressing changes (include mafenide acetate** or silver sulfadiazine; may alternate between the two), OR silver impregnated dressing changed q3-5d, OR Biobrane	Silver nitrate solution applied to dressings	Until healed
Deep partial thickness burns	Topical antimicrobials with daily dressing changes, OR silver impregnated dressing changed q3-5d, PLUS excision and grafting	Silver nitrate solution applied to dressings PLUS excision and grafting	Until healed or grafted
Full thickness burns	Topical antimicrobials with daily dressing changes PLUS excision and grafting	Silver nitrate solution applied to dressings PLUS excision and grafting	Until healed or grafted
Point of Injury/Delayed Evacuation			
Expected delay to reach surgical care	Moxifloxacin 400 mg PO x 1 dose. Ertapenem 1 g IV or IM if penetrating abdominal injury, shock, or unable to tolerate PO medications	Levofloxacin 500 mg PO x 1 dose. Cefotetan 2 g IV or IM q12h if penetrating abdominal injury, shock, or unable to tolerate PO medications	Single dose therapy

**Post-injury antimicrobial agents are recommended to prevent early post-traumatic infectious complications, including sepsis, secondary to common bacterial flora. Selection is based on narrowest spectrum and duration required to prevent early infections prior to adequate surgical wound management. This narrow spectrum is selected to avoid selection of resistant bacteria. The antimicrobials listed are not intended for use in established infections, where multidrug-resistant (MDR) or other nosocomial pathogens may be causing infection.*

†Cefazolin may be dosed based on body mass: 1 gram if weight < 80 kg (176 lbs), 2 grams if weight 81-160 kg (177-352 lbs), 3 grams if weight > 160 kg (>352 lbs); doses up to 12 grams daily are supported by FDA-approved package insert.

‡Pediatric dosing: cefazolin, 20-30 mg/kg IV q6-8h (maximum, 100 mg/kg/day); metronidazole, 7.5 mg/kg IV q6h; clindamycin 25-40mg/kg/day IV divided q6- 8h; ertapenem, 15 mg/kg IV or IM q12 (children up to 12 years) or 20 mg/kg IV or IM once daily (children over 12 years; maximum, 1 gm/day); ceftriaxone, 100 mg/kg/day IV divided q12-24h (dosing for CNS injury); levofloxacin, 8 mg/kg IV or PO q12h (levofloxacin is only FDA-approved in children for prophylaxis of inhalational anthrax in children > 6 months of age, but this dose is commonly used for other indications); vancomycin 60 mg/kg/day IV divided q6h (dosing for CNS injury); ciprofloxacin, 10mg/kg IV (or 10-20mg/kg PO) q12h.

§These guidelines do not advocate adding enhanced Gram negative bacteria coverage (i.e., addition of fluoroquinolone or aminoglycoside antimicrobials) in type III fractures.

***Mafenide acetate is contraindicated in infants less than 2 months of age.*

††Post-injury antimicrobial therapy as suggested by the Acute Traumatic Wound Management in the Prolonged Field Care Setting CPG.

APPENDIX C: TETANUS PROPHYLAXIS RECOMMENDATIONS

Tetanus Prophylaxis recommendations from the Advisory Committee on Immunization Practices

Figure. Tetanus Immunization Chart

Tetanus Immunization Status	Minor Clean Wound	Major Clean Wound	Contaminated Wound (War Wounds)
Fully immunized recent Td booster	N/A	N/A	N/A
Fully immunized Td booster 5–10 years ago	N/A	Tdap	Tdap
Fully immunized, no booster for >10 years	Tdap	Tdap	Tdap
Unknown, none, or incomplete immunization	Tdap	Tdap and TIG (250U)	Tdap and TIG (500U)

N/A, not applicable; Td, tetanus and diphtheria; Tdap, tetanus-diphtheria-acellular pertussis; TIG, tetanus immune globulin.
***Note**: Tetanus vaccination of mother gives her protection and protects the newborn in the first few weeks of life.*

Source: Special Operations Forces Medical Handbook, U.S. DoD. Reprinted from the JTS Acute Traumatic Wound Management – Prolonged Field Care CPG, 24 Jul 2017

* Such as, but not limited to, wounds contaminated with dirt, feces, soil, and saliva; puncture wounds; avulsions; and wounds resulting from missiles, crushing, burns, and frostbite.

† DTaP is recommended for children aged <7 years. Tdap is preferred to Td for persons aged ≥11 years who have not previously received Tdap. Persons aged ≥7 years who are not fully immunized against pertussis, tetanus or diphtheria should receive one dose of Tdap for wound management and as part of the catch-up series.

§ Persons with HIV infection or severe immunodeficiency who have contaminated wounds should also receive TIG, regardless of their history of tetanus immunization.

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APPENDIX D: POST EXPOSURE MANAGEMENT OF PERSONNEL

Post exposure management of personnel after occupational percutaneous and mucosal exposure to blood or any body fluids.

Table. Post Exposure Management of Personnel

Post Exposure Management of Personnel					
Healthcare Personnel Status	Post exposure testing		Post exposure prophylaxis		Post vaccination serologic testing †
	Source patient (HBs Ag)	HCP testing (anti-HBs)	HBIG*	Vaccination	
Documented responder § after complete series (≥3 doses)	**No action needed**				
Documented non-responder ¶ after 6 doses (2 complete series)	Positive/unknown		HBIG x2 separated by 1 month		No
	Negative	**No action needed**			
Response unknown after a complete series	Positive/unknown	‹ 10 mIU/mL	HBIG x1	Initiate revaccination	Yes
	Negative	‹ 10 mIU/mL	None		
	Any result	≥ 10 mIU/mL	**No action needed**		
Unvaccinated/incompletely vaccinated or vaccine refusers	Positive/unknown		HBIG x1	Complete vaccination	Yes
	Negative		None	Complete vaccination	Yes

(Morb Mortal Wkly Rep. 2018; 67(No. RR-1) [:1-31.])

Abbreviations: HCP – Healthcare Personnel; HBsAg – Hepatitis B surface antigen; anti-HBs – antibody to Hepatitis B surface antigen; HBIG – Hepatitis B immune globulin.

** HBIG should be administered intramuscularly as soon as possible after exposure when indicated. The effectiveness of HBIG when administered ›7 days after percutaneous, mucosal, or nonintact skin exposures is unknown. HBIG dosage is 0.06 mL/kg.*

† Should be performed 1-2 months after the last dose of the Hep B vaccine series (and 4-6 months after administration of HBIG to avoid detection of passively administered anti-HBs) using a quantitative method that allows detection of the protective concentration of anti-HBs (≥10 mIU/mL)

§ A responder is defined as a person with anti-HBs ≥10 mIU/mL after ≥3 doses of HepB vaccine.

¶ A nonresponder is defined as a person with anti-HBs ‹10 mIU/mL after ≥6 doses of HepB vaccine.

APPENDIX E : CHLORHEXIDINE ANTISEPTIC BODY CLEANING

(Adopted from LRMC Policy)

Policy: The chlorhexidine antiseptic body cleaning wash cloths will be used on all intensive care unit patients unless a patient declines or has any known sensitivities to ingredients.

Purpose: To reduce the risk of hospital associated infection by decreasing bacterial colonization that can cause skin infection.

Applicability: The antiseptic body cleaning wash cloths policy is applicable to all healthcare workers assigned to provide bedside bathing to patients in the medical facility.

Responsibility: It is the responsibility of the nursing managers to ensure that this policy is implemented correctly and consistently.

Exclusion: Avoid facial area, open wounds, and areas of 2nd or 3rd degree burned skin.

PROCEDURE

1. **When the patient arrives to the unit first bathe patient with soap/water add 30 cc of Hibiclens 4 % to the basin and bathe patient to remove all visible dirt.**
    a. Wait 6 hours after initial bath and bathe patient with antiseptic body cleaning washcloths once a day.
    b. Warming the antiseptic body cleaning washcloths (if warmer not available).
    c. Warm package in the dedicated microwave settings: 1000 watts for 30 seconds.
    d. Consult package for complete indications, ingredients, and warnings.
2. **Bathing a patient with antiseptic body cleaning washcloths**
    a. Wash hands prior to the procedure and don a pair of gloves and a gown.
    b. Explain the procedure to the patient.
    c. Ensure the patient has privacy. Have patient remove gown or assist in the removal as needed. Use a towel or sheet to cover the patient appropriately.
    d. Peel back the label on the package and test the temperature by touching the top washcloth. Remember, gloves diminish sensitivity to heat. If temperature is acceptable, proceed to the next step.
    e. Remove #1 washcloth.
        i. Test washcloth to back of patient's hand or inside wrist/forearm area.
        ii. Ask patient if the temperature is acceptable.
            - If acceptable, proceed with next step.
            - If NOT acceptable, STOP the procedure until temperature is acceptable to the patient.
            - Continue to monitor patient's comfort level with the temperature as the bath progresses.

f. For incontinence care, clean using terrycloth towels, soap and water, followed by wiping the involved skin with as many chlorhexidine cloths as necessary.

g. Apply clean gown, reposition and cover the patient.

h. Discard all disposables as general waste.

NOTE: Do not flush antiseptic body cleaning washcloths in the toilet!

i. Document procedure in progress notes.

Table. Wash cloth sequence

Cloth	Areas*	Action
***Do Not Use on Face**		
1	Both arms and chest	Discard
2	Perineum	Discard
3	Right Leg	Discard
4	Left Leg	Discard
5	Back	Discard
6	Buttocks	Discard

5. What To Do

a. Do use chlorhexidine (CHG) baths in place of daily bathing with soap and water.

b. Do massage firmly into skin to bind skin proteins and prevent bacteria for 24 hours.

c. Only use CHG-compatible lotions.

d. Use over superficial wounds, including stages 1 and 2 decubitus ulcers.

6. What NOT To Do

a. Do NOT use above jaw line.

b. Do NOT rinse or wipe off CHG. Let air dry.

c. Do NOT flush CHG cloths (discard in trash, not toilet or commode)

d. Do NOT include patients who are allergic to CHG.

APPENDIX F: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Inhalation Injury and Toxic Industrial Chemical Exposure

There are multiple toxic industrial chemicals that act on the respiratory tract. This CPG reviews common toxic industrial chemicals related in pulmonary injury

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PURPOSE

There are multiple toxic industrial chemicals that act on the respiratory tract. This CPG reviews the most common toxic industrial chemicals which lead to pulmonary injury.

More information is available from the Centers for Disease Control and Prevention:

- https://www.atsdr.cdc.gov/toxicsubstances.html
- Textbooks of Military Medicine https://medcoe.army.mil/borden-3-textbooks-of-military-medicine
- Patients with both burn and inhalation injury have significantly increased morbidity and mortality compared to those with burn injury alone.[1] This CPG is intended to review relevant information in the care of patients with inhalation injury and more specifically toxic industrial chemicals. Also included is a brief overview of the management strategies for these patients. We intend to inform caregivers with the goal of reducing some of the complications of inhalation injury.

GENERAL SMOKE INHALATION INJURY

Smoke inhalation injury occurs from several agents. Thermal injury and chemical injury are the primary initial toxicities. Chemical injury occurs from several materials of combustion and pyrolysis.[2] Highly water-soluble irritants such as acrolein, sulfur dioxide, hydrogen chloride and ammonia, and intermediate water soluble irritants such as chlorine and isocyanates are produced. Poorly water-soluble irritants are oxides of nitrogen and phosgene. Simple asphyxiants which displace oxygen include carbon dioxide and methane, and chemical asphyxiants which inhibit mitochondrial activity and reduce hemoglobin carrying capacity include carbon monoxide, cyanide, and hydrogen sulfide. Treatment is generally supportive. Some require antidotes. Most critically ill patients require unique ventilation techniques used for Acute Respiratory Distress Syndrome (ARDS). As toxic pulmonary agents lead to oxidative damage to lung tissues, similar to excessive oxygen supplementation, oxygen supplementation should be provided only as necessary to maintain sufficient oxygenation (pulse oximetry of 90% to 96%).[3]

TOXIC INDUSTRIAL CHEMICAL INHALATIONAL INJURY

In general, the treatment of ARDS secondary to toxic industrial chemicals is similar to that for smoke inhalation injury. The care is supportive with a focus on:

- Airway management.
- Lung-protective ventilation strategies.
- Aggressive pulmonary toilet.
- Avoidance of volume overload or rapid fluid infusion that might worsen pulmonary edema secondary to capillary leak.

PATIENTS REQUIRING MECHANICAL VENTILATION (MV) SECONDARY TO TOXIC INDUSTRIAL CHEMICAL INHALATION

Patients requiring MV secondary to toxic industrial chemicals inhalation, in particular chlorine, are at a higher risk of developing ventilator-associated pneumonia and should be monitored closely. The treatments in this CPG are primarily based on animal experiments. Evidence for clinical use in humans is limited.

CHLORINE

Chlorine (Cl_2) (Appendix A) is used commonly in industry. It is a commonly found in industrial and transportation accidents and are sometimes used in weapons such as improvised explosive devices. Chlorine dissolves in water to form hydrochloric and hypochlorous acids.

Chlorine has intermediate water solubility. Just after exposure the patient develops mucosal irritation (tearing, skin burning, drooling), but after large or sustained exposure the patient may develop cough, shortness of breath, and chest pain due to alveolar injury. Except for in cases of large exposure, upper airway symptoms proceed lower airway symptoms. If the patient develops pulmonary toxicity, it may worsen over days.

Treatment is primarily skin decontamination, supplemental oxygen as necessary, beta agonists and ARDS ventilatory techniques.[4] Inhaled corticosteroids (e.g., fluticasone) improved secondary outcomes in severely toxic animal models.[5] Clinical data on the efficacy of corticosteroids after human exposure to lung-damaging agents are inconclusive as the number of well-structured controlled studies is small and the indications for administration of corticosteroids are unclear.[6] Prone positioning mechanical ventilation may be effective.[7] Nebulized bicarbonate has not reliably improved outcomes.[4,6,8,9]

PHOSGENE

Phosgene (Carbonyl chloride, $COCl_2$) has a sweet, pleasant smell of mown hay. It is poorly water soluble, not noxious and does not prompt escape from the location by the victim. It was used in WWI as a chemical weapon. It is produced from the combustion of chlorinated hydrocarbons (welding, fires) and from synthesis of solvents (degreasers, cleaners). Phosgene is a respiratory irritant. Immediate effects may include coughing, burning sensation in throat and eyes, lacrimation, blurred vision, dyspnea, nausea and vomiting, and or cutaneous injury. High-dose inhalation may cause onset of pulmonary edema within 2-6 hours. High concentrations may produce a severe cough with laryngospasm that results in sudden death; this possibly could be due to phosgene hydrolysis, which releases free hydrochloric acid at the level of the larynx. On the other hand, delayed-onset pulmonary edema as late as 48 hours after exposure is also possible. Thus, patients should be monitored for that length of time after exposure.[10] The mechanism of toxicity is release of hydrochloric acid and reactive oxygen species and free radicals in the lung epithelial layers. Decontamination is typically not needed once the patient leaves the exposure. Treat with observation, supplemental oxygen, and ARDS ventilation techniques.

HYDROGEN SULFIDE

Hydrogen sulfide (H_2S) smells like rotten eggs and is a chemical irritant. Exposures occur in waste management, petroleum, natural gas industries, and asphalt and rubber factories. The gas acts like cyanide and inhibits cytochrome oxidase, preventing mitochondrial oxygen use and cellular respiration. At lower doses, H_2S causes skin and mucous membrane irritation. At high concentrations, it produces a “knockdown” effect, a sudden loss of consciousness. At these concentrations it can produce seizure, myocardial ischemia, keratoconjunctivitis, and upper airway and pulmonary injury. The vast majority of patients will have died prior to receiving medical care or will make a full recovery immediately after removal from the exposure. In those patients who do not immediately recover after removal from the exposure, treat with supplemental oxygen and intravenous hydroxocobalamin (5 g) or intravenous sodium nitrite (300 mg), and supportive care.[2] Inhalation of sodium nitrite is associated with methemoglobinemia and hypotension. Infuse it over 5-7 minutes.

AMMONIA

Ammonia (NH_3) is a common industrial and household chemical used as a fertilizer, refrigerant, cleaning agent. NH_3 has a pungent odor. It is also used in plastic and explosive synthesis. NH_3 is transported under pressure in liquid form at sub-zero temperatures. It reacts with water upon release, to form ammonium hydroxide (NH_4OH), a strong base, which produces mucosal irritation (tearing, skin irritation, eye pain and burns), severe upper airway irritation, and alkali skin burns. High concentrations or prolonged exposure duration (patient unconscious in a closed room) can produce tracheobronchial and pulmonary inflammation. It can produce respiratory failure within 2-5 minutes of exposure. Treat with skin and eye irrigation, alkali burn skin care, supplemental oxygen as necessary, ARDS ventilatory techniques, and supportive care.[4] Proper eye care, particularly copious irrigation, is essential immediately after the exposure. The eye is often the forgotten organ in a patient with an acute irritant gas exposure.[11]

OTHER COMMON CHEMICAL TOXINS RELATED TO INHALATIONAL EXPOSURES

CYANIDE

Cyanide (CN) is released in structural and vehicle fires and in occupational settings of chemical or synthetic material combustion. It is used in manufacturing of pesticides and synthetic materials, metal extraction, and in chemical laboratories. Cyanide inhibits mitochondrial cytochrome oxidase thereby halting cellular respiration and aerobic metabolism. Early or mild effects are mostly neurologic (dizziness, headache, nausea, and anxiety). Late or severe effects are coma, seizure, respiratory depression, hypotension, and tachycardia. ARDS and pulmonary edema can occur in severe cases. Coma precedes apnea, and then hypotension develops.

The triad of severe toxicity is hypotension, altered mental status, and lactic acidosis (commonly > 8 mmol/L).[12] Treat with oxygen, mechanical ventilation, and rapid administration of an antidote. Hydroxocobalamin, the most commonly available antidote (sold as Cyanokit®), binds to CN to form cyanocobalamin, which is nontoxic and excreted in the urine. The standard dose of 5 g is infused intravenously over 15 minutes. A second dose of 5 g can be administered in patients with severe toxicity or poor clinical response. It is generally regarded as safe. Red discoloration of the skin and urine is common which may interfere with colorimetric assays. Hydroxocobalamin has been compared to sodium nitrite (300 mg) and sodium thiosulfate (12.5 g), prior treatment options, and was found to be superior with less toxicity and the latter two therapies are now not recommended for severe cyanide toxicity.[13] Treatment with nitrites carries significant risk of hypotension and methemoglobinemia, which can further jeopardize tissue oxygen delivery.

CARBON MONOXIDE

Carbon monoxide (CO) is released from the combustion of carbon containing compounds with combustion engines and cooking stoves in enclosed spaces. CO has a high affinity for hemoglobin and displaces oxygen when present. This displacement of oxygen ultimately leads to decreased oxygen delivery at the tissue and mitochondrial level.[14] Symptoms of CO toxicity include confusion, stupor, coma, seizures, and myocardial infarction.[15] CO levels are traditionally measured using a co-oximeter, in a blood gas lab; however, this testing may not always be available and a high index of suspicion must be present as elevated CO may be present despite normal PaO2 and SpO2 readings. Newer non-invasive CO-oximetry may allow for early diagnosis and better monitoring.[16] Treatment of CO poisoning involves producing 100% oxygen, shortening the half-life of CO binding to hemoglobin to about 45 minutes. Hyperbaric oxygen therapy (HBO) has been used to reduce the half-life to about 20 minutes.[17] Logistical factors have limited the utilization of HBO and a systematic review found that not enough evidence exists at this point to determine definitively whether HBO reduces adverse neurologic outcomes after CO poisoning.

FIRE SUPPRESSANTS

Chemical fire suppressants are released in military vehicle fires. The most common is HFC227 (HFC-227EA, heptafluoropropane). It replaced bromotrifluoromethane (one of many "Halons") in military vehicles.[18] These "virgin Halons" were banned by the Environmental Protection Agency (EPA) in 1994.[19] HFC227 is inert, a simple asphyxiant, and no cases of combustion related toxicity have been published or reported to the EPA or Occupational Safety and Health Administration.[20,21] HFC227 can convert to hydrogen fluoride in small amounts during a fire, and; treatment is supportive, similar to other chemical exposures resulting in inhalation injury.[4] Hydrogen fluoride (HF) as a byproduct of combustion with standard fire suppression systems may cause severe inhalation injury. Exposure to HF may result in rapidly progressive or fatal respiratory failure despite minimal external evidence of injury. In human tissue, HF dissociates into the hydrogen and fluoride ions. Fluoride ions rapidly bind calcium, leading to fatal hypocalcemia induced cardiac dysrhythmias. Patients present typically with shortness of breath, cough, or hypoxia; there must be a high level of suspicion. The administration of nebulized calcium gluconate (1.5 ml of 10% Ca Gluconate in 4.5 ml water) every 4 hours may provide benefit. If the patient is hypocalcemic, intravenous calcium gluconate (1000 mg) or intravenous calcium chloride (1000 mg) through a central venous line) should be administered and repeated every 15 minutes until normalization of serum calcium for a minimum of 12 hours. In the absence of significant burns, consider steroids if symptoms do not improve. Bronchopneumonia can develop within the first week.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients diagnosed with smoke or toxic chemical inhalation exposure.

INTENT (EXPECTED OUTCOMES)

1. Patients with respiratory insufficiency and chemical exposure are intubated by the first surgical team admitting.
2. Examination of pharynx, larynx, trachea, and bronchi is documented for all patients in population of interest.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients with respiratory insufficiency who receive intubation.
2. Number and percentage of patients in population of interest who have documentation of examination of pharynx, larynx, trachea, and bronchi.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: CHLORINE INHALATION

Stratify chlorine toxic patients into no symptoms, mild, moderate, and severe. Treatment and observation periods can be tailored based on the severity of symptoms.

1. **No symptoms.** If no symptoms, then may be discharged if initial assessment (respiratory examination, vital signs, and pulse oximetry) is normal.
2. **Mild** (minimal symptoms, coughing, normal pulse oximetry, and no increased respiratory effort). Obtain chest radiograph, administer inhaled beta agonists, and observe for up to 6 hours. Most patients can be discharged.
3. **Moderate** (hypoxia, increased respiratory effort, normal chest radiograph) - Obtain chest radiograph, administer beta agonists, and admit for at least 12 hours. Consider inhaled steroids (fluticasone 200 mcg or similar agent) twice a day, early endotracheal intubation for increased respiratory effort, and inhaled ipratropium.
4. **Severe** (hypoxia, respiratory distress, often require intubation). Perform early endotracheal intubation with 8.0 tube to allow for bronchoscopy, obtain chest radiograph, administer beta agonists, and admit to ICU. Administer humidified oxygen and inhaled steroids (fluticasone 200 mcg or similar agent) twice a day. Consider inhaled ipratropium if not improving. If unable to administer inhaled steroids or if patient has significant bronchoconstriction consider intravenous steroids.

   ARDS. Perform similar ventilation strategies for ARDS, including increased positive end-expiratory pressure and low tidal volumes. Evaluate daily for barotrauma. The patient may require high doses of sedatives to maintain synchrony with the ventilator.

IMPORTANT CAVEATS

A patient who is close to a large, dense chlorine exposure (IED detonated chlorine tank) or suffers a sustained exposure (unconscious in a chlorine filled room) may develop upper airway edema. In these cases, perform early intubation. Examine all exposed patients for eye, mucosal, and skin contamination which is manifested by corneal burns/abrasions, mucosal swelling, and skin erythema, blister, or burns. Decontaminate all symptomatic skin surfaces. Remove all exposed clothing. The trauma evaluation and treatment takes priority over the chlorine toxicity. Nebulized bicarbonate has not been reliably effective. It is made by mixing 1 ml of 8.5% sodium bicarbonate in 3 ml saline to create a 2% solution.

POST DISCHARGE FOLLOW-UP

If available, obtain pulmonary function tests with lung volume assessment and diffusing capacity of the lungs for carbon monoxide. If the pulmonary function test is abnormal, obtain high resolution pulmonary CT scan to assess or pulmonary fibrosis.

BACKGROUND AND CLINICAL EFFECTS

Chlorine is a gas with intermediate water solubility. It will induce mild irritant symptoms (tearing, pungent smell, upper airway irritation), but will also induce delayed pulmonary edema following a dense or sustained exposure. Chlorine dissolution into lung water generates hydrochloric acid and hypochlorous acid. The hypochlorous acid decomposes to HCl and nascent oxygen (O-). The nascent O- produces additional lung damage by free-radical formation. Chlorine was used in World War I as a chemical warfare agent.

- **Early effects.** Irritation of the eyes, nasal mucosa, upper airway, coughing, shortness of breath, and chest pain or burning
- **Late effects.** Pulmonary congestion and edema and then ARDS.

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Interfacility Transport of Patients Between Theater Medical Treatment Facilities

This CPG recommends the minimum requirements to move critical care casualties after their entry into the evacuation system.

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INTRODUCTION

Reducing the time to required medical or surgical interventions prevents death in potentially survivable illness, injuries and wounds. When evacuation times are extended, en route care (ERC) capability must be adequately expanded to mitigate the delay. In January 2010, the *Joint Force Health Protection Joint Patient Movement Report* stated "the current success of the medical community is colored by the valiant ability to overcome deficiencies through "just-in-time workarounds;" many systemic shortfalls are resolved and become transparent to patient outcomes. However, future operations may not tolerate current deficiencies."[1] This Joint Trauma System (JTS) Clinical Practice Guideline (CPG) recommends the minimum requirements and capabilities for the movement of critical care patients between medical treatment facilities (MTFs). It is designed to mitigate historically recognized and potential future systemic shortfalls with the ultimate goal of improving case fatality rates, reducing morbidity, and eliminating preventable death. This guideline is also referred to as the inter-facility transport CPG for policy adoption within a Geographical Combatant Command (GCC) or Area of Operations (AOR). The focus of this guideline is to establish a system of systems approach to identify the clinical and operational elements essential to optimizing the ERC of patients during inter-facility transport across a combatant theater, to include austere and far forward locations. Transport may occur via land, sea, or air and involve multiple agencies or coalition partners.

Successful implementation of this CPG first requires medical personnel with the appropriate education, training and capabilities throughout the ERC system. Secondly, the use of specialized transport equipment, supplies, and protocols required to meet the clinical needs of patients in transit are detailed. Also, it cannot be over emphasized that success requires effective coordination between the medical team, vehicle operators and the command providing the vehicles. Care capability is almost always reduced during ERC. The tyranny of distance is related to time. Further complicating this threat with en route delays will contribute to preventable deaths. Effective communication, coordination and cooperation across the system mitigate this risk.

Through this CPG, the Committee on En Route Combat Casualty Care (CoERCCC) and the JTS strongly recommend the establishment of a positive, proactive and responsive medical direction capability along with dedicated medical dispatch centers to facilitate patient care and safety during the phases of transport. These phases consist of pre-movement (e.g., patient preparation and packaging), en route (e.g., continuation of care and management of acute complications), and post-movement (e.g., review of documentation and patient outcomes) overseen by direct and indirect medical leadership. A systems of systems approach will help mitigate the risks associated with patient transport, and as described in this CPG will include: expected ERC capabilities, types of ERC providers, transport platforms and medical materiel, dispatch centers, medical direction, treatment protocols, documentation of care requirements, and patient transfer criteria.[1]

Unity of command is critical in this endeavor. While "unity of effort" suggests that multiple parties are working toward a shared goal in a coordinated way, it is not the same as "unity of command." Unity of command represents a unified and focused effort that is essential for success in complex objectives. Specifically, "unity of command" is predicated on one person ultimately being in charge of the process though many people are working toward the outcome.[2] Commanders must establish leadership positions with defined roles, responsibilities and the delegated authority to execute successful ERC. Competent military authority of the ERC system is required because success involves the synchronization of multiple teams, the transfer of patient care across those teams, and the myriad challenges of delivering care in operational environments. Subsequently, capability requirements for ERC must be established, promulgated and effectively enforced to ensure that the capability to deliver life-saving ERC is afforded the ill, injured and wounded.

This guideline is specifically concerned with the inter-facility transport of patients between the intra-theater roles of care including transfer between MTFs and civilian treatment facilities. Please refer to Tactical Combat Casualty Care-Tactical Evacuation Care guidelines for Point of Injury (POI) transport and to Aeromedical Evacuation (AE) guidelines for inter-theater transport.

It is important to note, in an immature theater of operations or in a larger scale conflict, casualty numbers may exceed available resources. When this occurs, compliance with this guideline may be compromised. Commanders need to ensure appropriate patient movement resources are a priority, especially for critical care transports between treatment facilities.

BACKGROUND

After years of conflict in Iraq and Afghanistan, the Military Health System is rightly proud of a 98% casualty survival rate for patients reaching a Role 3 facility. Unfortunately, this statistic excludes those casualties who die before reaching the Role 3 facility. According to Eastridge et al in *Death on the battlefield (2001–2011): Implications for the future of combat casualty care,* 87.3% of the total combat deaths occur prior to arrival at the Role 3 facility, highlighting the opportunity for further improvements.[3] ERC is a significant patient care component both from the POI to an MTF and after damage control resuscitation and surgery to the next MTF or to an aerial port of debarkation (APO) for movement out of theater.

Inter-facility transport presents an "added challenge" and is associated with increased risk to the patient.[4,5] These movements typically occur in combatant vehicles and, due to physical space limitations and operational demands, there are fewer providers giving care. And, while the number and complexity of interventions are limited, they are also more difficult to execute. Noise, vibration, and cramped spaces act together to disconnect lines, displace tubes, shift dressings, impede patient monitoring, and directly antagonize injuries. Environmental conditions and inclement weather during transport can contribute to morbidity and mortality. If flying, the reduced barometric pressure results in lowered partial pressure of oxygen, increased size of gas pockets, decreased tissue perfusion, and increased tissue swelling.[6] The enemy and diplomatic considerations may also effect routes, duration of transport and the safety of movement. Good ERC systems and teams recognize these risks and mitigate their threats.

Transporting patients is a medical intervention itself and although very common still has risks and benefits. A central tenet of combat medicine is clearing the battlefield by transporting patients between facilities. Transport may be required because of the patient's condition or the organization's mission. The reality of war and military doctrine is that casualties must be evacuated until they receive definitive treatment. Consolidation and centralization of medical resources reduces their physical footprint, diminishes the need for re-location during combat maneuvers, avoids the loss of medical capability during re-location, and decreases the associated global logistical demands on the combatant command. The decision to transport is nearly reflexive, and rightly so. But, the risks inherent to transport must be minimized through a robust system of care dedicated to optimizing patient outcomes during transport. Besides the direct medical risk to the patient of the physical movement, loss of the transport asset and crew to accident or enemy action is real. There are many recurrent examples of both civilian and military medical evacuation helicopters being lost to environmental threats and enemy action flying missions that were probably not critical to life, limb or eyesight.

PATIENT STABILIZATION

In order to minimize transport contribution to morbidity and mortality, optimal but not necessarily definitive patient stabilization before transport is critical and encompasses four connected elements. First, injuries—actual and potential (e.g. spinal instability)—must be controlled. This usually happens at the earliest phase of tactical combat casualty care. Second, resuscitation must be optimized but may be ongoing. The best outcomes occur when a patient's physiology is closest to normal before transport.[7,8] Patient variables that best indicate adequate resuscitation for transport continues to be an area for continued basic and translational research.[9,10,11,12] Third, other treatments besides resuscitative measures should be at steady-state, not requiring dynamic, complex, or life-preserving adjustments en route. Until technology progresses, the planned initiation of new interventions or the continuation of complex or capability unique interventions during transport are

discouraged. Finally, deterioration requiring en route intervention must be anticipated and prevented with risk mitigation procedures prior to departure. Examples include placing lines or tubes, or decompressing compartment syndromes, as well as providing adequate analgesia for the increased pain of transport. This requires an understanding of the injury course as well as the transport environment.

Preparation for transport must include more than just patient physiology. Packaging to ensure safety during the transitions of care is also essential. This includes the logistical and the indirectly clinical aspects of getting the patient ready for transfer from the treatment facility to the ERC team. Many of these steps can be managed by the non-physician members of the transferring team but must be verified by the ERC providers prior to departure.

EXPECTED ERC CAPABILITIES

Medical capability is the quality or state of being able to provide the expected and required medical services and support to the casualty. Within the system of en route care, and when capability is discussed in this document, it is the ready and available potential to provide the required critical care in a proficient and timely manner. It includes the physical and mental talent of the team, as well as the physical presence of all medical materials and equipment in the vehicle that are expected by theater policy. A capability does not exist if the personnel are not proficient or if they are missing medical supplies and equipment. Nor is capability present if the ERC team is not integrated effectively with the transport platform team. Therefore, units must be conversant and compliant with the published theater standards along with being physically and materially ready to execute the assigned mission. Within the operational theater it is critical to ensure actual capability is effectively communicated between medical control, the transferring facility, the ERC team, and the receiving facility. The ERC organization has a moral, ethical and legal obligation to ensure they can carry out their mission essential task list and mission essential care capability for the patient. If not, they must notify their commander, the medical director, and the medical dispatch center that they are unable to provide the expected and required care to our critically ill, injured or wounded patients. Since medical evacuation is a theater asset, the local unit commander cannot legitimately accept risk for the theater commander. Locally accepting risk of a reduced capability compromises care, contributes to excess morbidity and mortality and is inconsistent with the effective and efficient use of medical dispatch centers. It is the center's mission to select and assign the appropriate evacuation asset to the right mission.

A minimum of two levels of capability are recognized in this guideline: Critical Care and Intermediate Care. The ideal military ERC system will be a scalable and modular asset with appropriate resource allocation to provide a full range of patient care services to include advanced clinical capabilities.

Critical Care transport is required when "the patient has a critical illness or injury that acutely impairs one or more vital organ systems such that there is a high probability of imminent or life-threatening deterioration in the patient's condition during transport." For success, en route critical care must be provided by a team of providers "with the requisite decision making skills of high complexity to assess, manipulate, and support vital organ system failure and/or to prevent further life threatening deterioration of the patient's condition during transport."[13] Ideally, this team will be led by a physician or other independent practitioner with extensive critical care experience and the requisite equipment to perform lifesaving interventions as required by the clinical scenario.

Sometimes a completely packaged and fully stabilized patient is operationally unrealistic. Some injuries or illnesses cannot be stabilized due to capability limitations. Limited capability may be the driving indication for transport. These transfers are fraught with the risks of undesired outcomes during transport. Subsequently, the transferring provider should document the indications for transport before patient movement, continue the resuscitation and ensure adequate (even higher) capability of the ERC. The gold standard for unstable patient

transport is movement with critical care capability led by a physician who is qualified, experienced, and proficient at critical care transport.

Intermediate ERC should be initiated for a patient that does not require critical care but is in need of a dedicated medical attendant with at least the knowledge and skills equivalent to a paramedic as defined by the National Emergency Medical Services (EMS) Scope of Practice Model. Adequate medical supplies to perform lifesaving interventions as well as ongoing resuscitation are also necessary. Patients in this category have some complexity of care delivery that must be maintained by a medically skilled provider but are not expected to deteriorate during the period of the patient movement.

Required ERC capability should be based on the current condition of the patient being transferred and their expected course during transport. This is determined by the transferring provider. If the requested level of ERC is not available, then a higher level of care should be provided. If this is not an option, then the transferring provider and the operational commander must carefully weigh the risks of patient transfer using a lower capability versus the risks of transport delay.

COMMANDERS

Joint Publication 1 states that, "…doctrine will be followed except when, in the judgment of the commander, exceptional circumstances dictate otherwise." The Commanders have specific responsibilities under Title 10, United States Code (USC), to organize, train, equip, prepare, and maintain their forces. For the purposes of this document that responsibility is ERC capability. Commanders are delegated the authority to accomplish their assigned missions but cannot absolve themselves of the responsibility for the attainment of these missions. Commanders of dedicated medical evacuation organizations shall not individually assume risk when they are not capable of providing the required intratheater ERC capability. Any risk assumption of reduced capability should be assumed by the theater commander as medical evacuation is a theater level responsibility. It is the commander's duty to notify higher command if they cannot execute their mission essential task list. Inherent to ERC within the mission essential task list is the capability to care for the patient with the level of care that is expected and required by the mission and the condition of the patient. Except as noted in Joint Publication 1 regarding exceptional circumstances, the advertised capability must be present during transport or increased morbidity and mortality rates will result. This has been demonstrated across evidence-based medical reviews and studies.[1]

TYPES OF ERC PROVIDERS

Health care teams are comprised of a variety of different provider types, and the ERC mission is no exception. ERC providers must receive formal education and training to ensure platform familiarization and vehicle crew resource management. Updating military ERC systems based on cautious application of civilian best practices should be tempered by a realistic understanding of operational considerations. Over 67% of civilian Helicopter Emergency Medical Services (HEMS) agencies in the United States staff their helicopters with Critical Care Flight Nurse/Critical Care Flight Paramedic teams.[14] Most ground EMS agencies use some variation of an Emergency Medical Technician (EMT) and Paramedic team. International HEMS agencies frequently use physician-led critical care transport teams.

The National EMS Scope of Practice Model is the core document that describes scope of practice for civilian EMS providers in the United States. These civilian levels of EMS provider, typically applied to enlisted medical providers, are Emergency Medical Responder, EMT, Advanced EMT, and Paramedic. Registered Nurses with education and training applicable to prehospital care have several advanced certifications available to validate their skill and knowledge proficiency, to include: Critical Care Flight Nurse, Certification in Emergency Nursing, Critical Care Registered Nurse, and others. Although not common in the United States, several international EMS systems educate, train, and certify physicians as prehospital providers and the United Kingdom (UK) Medical

Emergency Response Team (MERT) platform is the most well-known from use in the Regional Command South of Afghanistan.

Higher competency and capability improves case fatality rates when patients are transported. During Operation Enduring Freedom, care provided by critical care flight paramedics showed a 66% lower risk of 48-hour mortality compared with that of basic level EMTs.[15] In the UK, prehospital critical care is provided by physician-staffed HEMS. These teams have demonstrated survival in cases previously thought to be non-survivable (e.g., traumatic cardiac arrest).[16] British military platforms with on board intensivists have likewise demonstrated improved survival in more severely injured patients.[17]

It is imperative to understand the attributes of the different provider types based on their qualifications and certifications. Instrumental to ensuring capability is the verification of currency of their practice experience and their skill proficiency. Additionally, well trained teams improve outcomes so ERC teams who train together prior to operational assignment may optimize patient outcomes.

TRANSPORT PLATFORMS AND MEDICAL MATERIEL

Patient transport is conducted as a planned component of a given mission aboard dedicated vehicles or transports of opportunity. Understanding the capabilities and limitations of the transport platform will help ERC providers, mission planners, and medical control optimize the care they deliver. This requires the appropriate selection capability to conduct the mission based on the provider team, resuscitative equipment, treatment protocols and vehicular capabilities to move through the environment. For some ERC missions, the transport may require serial transfers between different vehicles and modes of transport. Familiarization with the different vehicles available in a theater of operations is imperative.

Weight and space restrictions, as well as the challenges of patient transport in an operational setting, necessitate the deliberate and careful selection of medical materials for a given mission. The provider's competency and the medical material actually present in the vehicle determine ERC capability. Vehicle selection will directly impact personnel and equipment availability and determine the highest level of care. Vehicles should be chosen with an understanding of the patient condition and must be appropriate for the type of ERC provider. Specific medical materials designated as patient movement items (PMI) must be available to support the patient during every phase of transport. Examples of PMI include ventilators, patient monitors, pulse oximeters, suction machines, IV pumps, oversized litters, negative pressure wound vacuums, pneumatic compression stockings/devices and more.[18] It is important the transferring facility request these items so that they can be loaded and transported with the ERC team. Whenever possible, the expendable medical supplies like oxygen from the transferring facility should be used until the last safe moment before departure. This action conserves the onboard medical supplies which cannot be replenished without stopping and delaying the transport. Additional information on PMI is found in the Aeromedical Evacuation Equipment Standards (AFI 10-2909), JP 4-02 and FM 4-02.1.

DISPATCH CENTERS

Tasking of limited resources while providing an appropriate ERC response requires a dedicated team with a comprehensive and current understanding of its assets and their current capabilities. This dispatch center should allocate resources based on mission requirements, the request of the transferring provider, the expected need from across the catchment area, and the capabilities of the available ERC units. Medical evacuation dispatch centers can vary but all should be co-located within a command and control (C2) communications center to coordinate efforts. Examples of dispatch centers include the U.S. Army's Theater Patient Movement Center for ground and rotary air ambulance medical evacuation and the joint activity Patient Movement Requirements Center for fixed wing aeromedical evacuation assets. Some multi-national AORs have Patient Evacuation Coordination Cells as dispatch centers for medical evacuation.[19,20,21] Whatever the configuration of

the dispatch center, they require detailed information to ensure the best allocation of available resources. This detailed information includes the validation and the verification of capability as resources increase and decrease with operational tempo and demands.

The 9-line medical evacuation request provides critical decision-making information in a standardized message format that helps expedite the medical evacuation process. A patient's condition, the operational situation, terrain, weather conditions, enemy threat and availability of assets are communicated in the 9-line request and taken into consideration by the dispatch center when determining the best transport vehicle and type of provider to send. Accurate medical evacuation precedence determination ensures an appropriate dispatch of capability. Urgency of medical care provided by the transferring facility is used to determine the medical evacuation precedence. The senior military person (or designated on-ground mission commander) present in coordination with the senior medical person determines when to request medical evacuation and the precedence assigned to the patient for evacuation. The on-site personnel should determine the evacuation precedence and discrepancies between the ground force precedence and the dispatch center will err on the side of higher acuity with further discussion reserved for after mission completion and the immediate run review process.

CAUTION: *Terminology used to communicate precedence is not consistent across services. Terminology for air (rotary wing) and ground ambulances shall be used for inter-facility transports and is provided in Table 2.*

Table 1. NATO 9 Line Medical Evacuation (MEDEVAC) Request

Line	Title	Explanation	Reason
1	Location/Pick up site	Eight or ten digit grid coordinates of pick up site	Required to know where to pick up the patient
2	Radio frequency, call sign	Frequency of radio at the pickup site Call sign of the person to be contacted at the pickup site	Evacuation vehicle can contact requesting unit while en route
3	Number of patients by precedence	A—URGENT B—URGENT-SURG C—PRIORITY D—ROUTINE E—CONVENIENCE	Assist command and control in prioritizing evacuation unit missions
4	Special equipment required	A—None B—Hoist C—Extraction equipment D—Ventilator	Required to have needed equipment loaded prior to mission start
5	Number of patients by type	L+# of patients–Litter A+# of patients– Ambulatory (sitting)	Needed to have appropriate number of vehicles dispatched
6	Security of pick-up site (wartime)	N—No enemy troops in area P—Possibly enemy troops in area (approach with caution) E—Enemy troops in area (approach with caution) X—Enemy troops in area (armed escort required)	For situational awareness and planning
6	Number and type of wound, injury or illness (peacetime)	Specific patient information on wound type (gunshot, blunt force, or explosive device) Serious bleeding and patient blood type if known	Assists evacuation personnel in determining required treatment and special equipment needed

Line	Title	Explanation	Reason
7	Method of marking pickup site	A—Panels B—Pyrotechnic signal C—Smoke signal D—None E—Other	Assists the evacuation crew in identifying the specific location of the pick up
8	Patient nationality and status	A—U.S. military B—U.S. civilian C—Non-U.S. military D—Non-U.S. civilian E—Enemy prisoner of war	Assists in planning for destination facilities and the need for guards.
9	Chemical, biological, radiological, and nuclear contamination (wartime)	Include this line only when applicable C—Chemical B—Biological R—Radiological N—Nuclear	Assists in planning for the mission.
9	Terrain description (peace time)	Identify terrain features in and around proposed landing or pickup site (lake, tower, ridge, mountain).	
+ 	M I S T	M – Mechanism of injury I – Type of Injury S – Signs (vital signs) T – Treatment given	Recently incorporated into use. May also include adult or child notification.

Table 2. Comparison of Medical Precedence Terminology [22,23]

Air ambulance (rotary wing)/Ground Ambulance	USAF AE
Priority I, URGENT (evacuate within a maximum of 1 hour)	Priority I, URGENT (evacuated immediately)
Priority IA, URGENT-SURGICAL- (requires far forward surgical intervention to save life and stabilize for further evacuation)	
Priority II, PRIORITY (evacuate within 4 hours or will become URGENT)	Priority II, PRIORITY (evacuate within 24 hours)
Priority III, ROUTINE (evacuate within 24 hours).	Priority III, ROUTINE (evacuate within 72 hours)
Priority IV, CONVENIENCE (rather than necessity). US Army priority not used by USAF	
The USAF uses slightly different precedence categories for patient aeromedical evacuation (AE) on fixed wing aircraft.	

MEDICAL DIRECTION

Medical direction is a critically important aspect of ensuring the delivery of an expected capability of care in the out of hospital environment.[24,25,26] While medical direction may be delegated to any physician regardless of specialty, it does require some unique knowledge and skills. Medical direction has traditionally been the responsibility of the unit physician (flight surgeon for example), although most of these providers do not receive additional formalized or structured education or training for this duty.

Medical direction encompasses both online and offline clinical guidance.[24] This CPG defines medical direction as the direct technical authority to determine capability, promulgate medical policy, and most importantly, the authority to enforce the standard of care through quality assurance with local privileging (official designation of ability to perform medical mission not necessarily the hospital version of "credentialing") actions of individual ERC providers. Online medical direction includes both the on-scene medical supervision of providers actively engaged in patient care, as well as real time clinical guidance of providers via telecommunication.[27] Offline medical direction includes protocol development and review, continuing education of prehospital providers, quality improvement activities, and other duties designed to increase the quality of the system but are not related to immediate and direct patient care.[24] Medical direction can occur at many levels. This CPG will focus on the requirements and responsibilities for unit level medical direction and regional medical direction. The primary mission of the medical director is to ensure the commander is effectively advised on the technical requirements of medical evacuation and the transport unit is meeting expected patient care capability and quality.

The commander of the unit assigned to perform medical evacuation should appoint the unit's physician as the medical director. The medical director is responsible for the technical control and supervision of all en route medical activities of the command and should be delegated that authority in writing. This additional duty order should also include the authority to privilege ERC providers within that organization. It should also include delegation of the authority and prerogative to hold in abeyance, to deny, or to immediately but temporarily suspend clinical privileges/practice when there is reasonable cause to doubt the individual's competence to practice or for any other cause affecting the safety of patients or others. The specific intent of the medical director's decision to implement temporary adverse privileging actions should be the safety and well-being of all patients and safeguarding the quality and efficiency of care delivered by the ERC organization. If a unit physician is not available to provide medical direction the unit conducting medical evacuation should coordinate with the supporting medical treatment facility for a shared medical director.

MINIMUM RECOMMENDED QUALIFICATIONS (UNIT MEDICAL DIRECTOR)

1. Duly commissioned officer in the Medical Corps of the Armed Forces of the United States.
2. Knowledge of ERC mission provided by the unit, unit treatment protocols and CPGs, and capabilities of unit's providers.
3. Completion of the Tactical Combat Medical Care or similar course.
4. Completion of the Joint En Route Care Course (if rotary wing unit) or similar course.
5. Medical director and operational medicine training.

DESIRABLE QUALIFICATIONS (UNIT MEDICAL DIRECTOR)

1. Board certification or eligibility in any specialty recognized by American Board of Medical Specialties or American Osteopathic Association or experience in operational medicine.
2. Previous operational medicine assignments.
3. Experience in medical direction for ERC.

RESPONSIBILITIES (UNIT MEDICAL DIRECTOR)

1. **Offline medical direction:**
    a. Chart reviews of all cases personally or through delegation.
    b. Continuous quality improvement/practice improvement activities.
    c. Detailed case reviews on selected cases from chart review protocol variations or high risk low frequency interventions.

d. Protocol development.

e. Develops criteria for types of providers needed to transport patients based on clinical condition.

f. Oversight of education and training of unit medical providers.

g. Notify the next higher level of command surgeon/theater medical director of systemic issues identified.

h. Conduct a quality assurance program and performance improvement program to ensure standardization of care delivered in accordance with regulations or instructions and Service and Combatant Command policies while validating practices and to propose new practices in ERC.

i. Unit privileging, through technical oversight and supervision, ensuring that providers are qualified, current and proficient in their ERC duties and responsibilities.

j. Ensures completion and delivery of patient care reports into the patient record and the Joint Trauma System.

2. Online medical direction:

a. Due to communication and patient care challenges unique to the deployed environment online medical direction may be most effectively done by physicians other than the transporting unit medical director.[27]

b. Priority of online medical direction is:

i. Transferring physician.

ii. Receiving physician.

iii. Transporting unit medical director.

c. Transporting unit medical director is responsible for ensuring providers know who and under what circumstances to call for online medical direction. It is important to plan/discuss whenever possible any anticipated scenarios requiring deviation from established ERC provider protocols with transferring physician to ensure required medical supplies are available during transport.

Medical direction is required at the unit level and also at the regional level (Patient Evacuation Control Center). Medical direction at the regional level is centered on offline medical direction activities. Regional medical direction works continuously to increase the quality of care delivered during intra-theater transport. Regional medical direction may occur at different levels based on the operating environment but will typically be at the level of the joint operations area and lower. The Joint Force Surgeon's office is the doctrinal proponent for intra-theater patient transport and should assign regional medical directors. A best practice is to appoint a consultant at the Combined Joint Task Force level for EMS and ERC. The Joint Force Surgeon's office shall provide regional medical direction unless they delegate this authority to subordinate regional medical directors.

MINIMUM QUALIFICATIONS (REGIONAL MEDICAL DIRECTOR)

1. Board Certification in a specialty recognized by the American Board of Medical Specialties or American Osteopathic Association, and experience in Operational Medicine and/or extensive experience in en route care.
2. Knowledge about the transporting environment and capabilities of units operating in theater.

DESIRABLE QUALIFICATIONS (REGIONAL MEDICAL DIRECTOR)

1. Previous work as a unit medical provider.
2. Board eligible/certified in EMS (vice fellowship training in EMS).

RESPONSIBILITIES (REGIONAL MEDICAL DIRECTOR)

1. In conjunction with medical planners advise the Combatant/Theater Commander on medical common operating picture and allocation of resources for intra-theater transport.
2. Ensure requirements of documentation of intra-theater transport care are done.
3. Assist medical directors operating in theater and ensure that they have the knowledge and skills to perform the job.
4. Provide technical supervision to medical directors in theater.
5. Ensure relevant out of hospital research is supported and accomplished.
6. Ensure information from intra-theater transportation is supplied to the DoD Trauma Registry.

The Committee on En Route Combat Casualty Care of the JTS recommends the development of service-agnostic courses for Medical Corps officers to serve as entry level training for Medical Directors covering the fundamentals for physician leadership in EMS and ERC oversight and direction.

TREATMENT PROTOCOLS

The recognition of the importance of hospital based CPGs prompted the Institute of Medicine to release a report in 2006 recommending the development of an "evidence-based model for pre-hospital care protocol for the treatment, triage, and transport of patients."[28] By using a consistent approach to a particular kind of patient, it is hoped that critical actions will not be missed, less overall errors will occur, and the patient will get the appropriate, evidence based treatment required. A prehospital medical protocol is directive in nature and guides non-physician providers with patient care decisions in the absence of on-scene or online physician direction. Given their limited scope of practice, the providers are generally expected to follow the protocols as written. The use of protocols is already wide spread throughout the civilian ground and air medical transport arena, as well as within the U.S. Army's new critical care flight paramedic program.

A systematic review looking at the effect of evidence-based clinical guidelines on patient outcomes in the Netherlands found that there was a significant improvement in the process and structure of patient care, and a smaller but significant improvement in outcomes.[29] Another retrospective study reviewed patient outcomes after the implementation of a series of evidence based protocols in an intensive care unit. They noted a small but significant decrease in mortality after the protocols were instituted.[30] A pre-hospital related study compared on-line medical direction of EMS personnel by an emergency nurse to a protocol based method of medical direction. The study found that there was a small improvement in the appropriateness of treatment decisions and a decrease in on scene time in the protocol based group as compared to the online group.[31]

While there is a limited amount of system based protocol research, there are many examples where the implementation of individual protocols have improved patient outcomes.[32,33]

In addition to guiding patient care, protocols also provide a means for performing quality assurance and developing research.[34] By providing a standardized approach to medical care, any deviations from the protocol can be noted, evaluated, and addressed as needed across the EMS system. When gaps in practice are identified, there is also potential for research into causes and solutions to address them. These protocols require regular review and at minimum annual revision.

DOCUMENTATION OF CARE

- Inter-facility patient transports must be documented on an approved patient care record (PCR).
- JTS approved PCR's include:
  - DD Form 1380 Tactical Combat Casualty Care (TCCC) Care
  - DA 4700 overprint Tactical Evacuation Patient Care Record (JTS approved 20141119)
  - AF IMT 3899 Patient Movement Record (20060819, V1)
  - Medical Rescue Report SAR Form 3-50.1A

The Tactical Evacuation Patient Care Record is primarily used for rotary wing transports from point of injury or inter-facility transfer. The AF IMT 3899 is primarily used for Aeromedical Evacuation, with supplements A through K as indicated for Critical Care Air Transport Team movements. The Medical Rescue Report SAR Form 3-50.1A is required whenever a search or rescue is attempted or accomplished that involves Navy personnel or assets. (NTTP 3-50.1)

When completing the PCR, it is important to ensure that the patient's name on the PCR matches the name entered on arrival to the MTF. In cases where a casualty's name is unknown, the MTF will utilize theater predetermined trauma identities. Transport teams must obtain an ID sticker at the time of handover to the MTF to ensure the correct identity is recorded on the PCR.

The PCR should be completed and delivered to the receiving MTF along with the patient. Completed PCR's and After Action Reviews may be submitted to JTS Prehospital at the following email address: usarmy.jbsa.medcom-aisr.list.jts-prehospital@mail.mil

At the time of handover to the MTF, the ERC team will provide a MIST (Mechanism, Injuries, Vital Signs, and Treatments) report summarizing the care received. The MIST report will be recorded by the receiving team on the DD Form 3019 Resuscitation Record for trauma patients, or in the Emergency Department record for non-trauma patients.

The CoERCCC and JTS recommend the development and implementation of ERC checklists for all phases of ERC that serve as clinical decision support tools. An example is found in Appendix A.

PATIENT TRANSPORT CRITERIA

Patient Preparation

1. **Patient stabilized:** ***as much as practical, if incomplete then High Risk Move (see below)*

- ☐ Injuries controlled
- ☐ Resuscitation complete (see below)
- ☐ Treatments steady, non-critical
- ☐ Deterioration en route prophylaxed

2. Patient packaged: **always do*

- ☐ Trauma identity sticker affixed
- ☐ Documentation ready for SBAR hand-off
- ☐ Lines & tubes anticipated, secured
- ☐ Send-along drugs, fluids/blood, equipment ready
- ☐ Exposure protection: eye-pro, hypothermia prevention, ear-pro
- ☐ Military ID/ passport included
- ☐ Belongings cleared if accompanying

3. En-route level of care selected:

- ☐ ICU-level/non-stabilized/high risk patient = gold standard* team
- ☐ Flight Paramedic (+/- ECCN)

*gold standard = multiperson, intensivist-led, qualified/current/proficient

Resuscitation Goals

1. Heart Rate 50-120 /min
2. SBP >90 mm Hg (MAP >60 mm Hg)
3. SpO2 >90-96%,[1] FiO2 required <50%
4. Temp > 95ºF/35ºC
5. Urine Output > 50 mL/h
6. Hemoglobin > 8.0 g/dL
7. Platelets > 50k/mm³
8. INR < 2.0
9. Base Deficit < 6
10. Lactate < 2.5 mmol/L

High Risk: stabilization or resuscitation incomplete/ ICU-level patient

1. Optimize resuscitation as much as possible.
2. Re-verify patient packaging.
3. Require intensivist-led en route critical care team.
4. Document reason for transport before full resuscitation, and risk mitigation steps
5. Collaborate with (1) en route team's physician, and (2) local medical director

1. *Ginde AA. Strategy to Avoid Excessive Oxygen (SAVE-O2) in Critically Ill Trauma Patients: A Multicenter Cluster-Randomized, Stepped Wedge Trial for Targeted Normoxemia. Scientific Plenary Presentation (MHSRS-23-10446), Military Health System Research Symposium; August 14, 2023.*

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All transported patients (intratheater, interfacility within theater).

INTENT (EXPECTED OUTCOMES)

1. All patients in population of interest have patient care documented on an approved record form.
2. Casualties requiring mechanical ventilation are transported by an enroute critical care provider (critical care flight paramedic, enroute critical care nurse, critical care physician assistant, or critical care physician).
3. Casualties are assessed for adequacy of resuscitation prior to interfacility transfer. For patients with any of the following parameters: HR < 50 or >120, systolic BP <90, core temperature <35 ℃, SpO2 <90%[36] on supplemental O2, Hct <21, base deficit below -5, or pH < 7.3, documentation indicates the need for transfer prior to restoration of physiology to more normal parameters.
4. Ventilated patients are placed on the transport ventilator, all monitors in place and stabilized for 30 minutes prior to departure from the current role of care to the aircraft and a final check for stability is performed/documented prior to wheels up and departure from that role of care.
5. Ventilated patients will receive lung protective ventilator settings (e.g., tidal volume 6-8 ml/kg) and have ventilator settings documented.
6. A hard copy of the medical record accompanies the patient.

PERFORMANCE / ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with patient care documented on an approved record form.
2. Number and percentage of patients on mechanical ventilation who are transported by an enroute critical care provider (critical care flight paramedic, en route critical care nurse, critical care physician assistant, or critical care physician).
3. Number and percentage of patients in the population of interest who are transported prior to physiologic stabilization (HR < 50 or >120, systolic BP <90, core temperature <35 ℃, SpO2 <90% on supplemental O2, Hct <21, base deficit below -5, or pH < 7.3).
4. Number and percentage of patients on mechanical ventilation who are placed on the transport ventilator, all monitors in place and stabilized for 30 minutes prior to departure from the current role of care to the aircraft.
5. Number and percentage of patients who had a final check for stability performed/documented prior to wheels up and departure from that role of care.
6. Number and percentage of patients on mechanical ventilation who had ventilator settings documented.
7. Number and percentage of patients on mechanical ventilation who had ventilator settings documented and with tidal volume 6-8 mL/kg.
8. Number and percentage of patients who had a hard copy of the medical record that accompanied the patient during interfacility transfer.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

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APPENDIX A: PATIENT TRANSPORT PREPARATION CHECKLIST

Source: U.S. Army Medevac Critical Care Flight Paramedic Standard Medical Operating Guidelines, FY18 Version, Published Oct 19 2017

PRE-FLIGHT CHECKLIST

(for Critical Care and Post-Surgical Transfers)

Once the decision is made to transfer a patient and an accepting physician has been obtained, the following steps will be taken to prepare the patient for transport:

Initials	Evaluation Steps
	1. Sending location/physician: _____Accepting location/physician:_____ Flight nurse called: name / time: _____
	2. Anesthesia called: intubation if indicated. **ETT secured**/marked
	3. Patient meets criteria for en route critical care transport: risk documented by sending physician **(POST-OPERATIVE and CC INTRAFACILITY TRANSFER, Pre-Transfer Patient Status Requirements)**
	Preparation Steps
	Positioning and Proper Monitoring:
	1. Patient moved to litter (collapsible handles), positioned, padded, strapped, equipment (with necessary attachments) added and secured.
	2. For head-injured patients, a pre-sedation neurologic examination will be performed. GCS and neurological exam documented on the en route care form, suggest placing patient sitting at 30°-45°. (For eye injured patients, fox shield in place. For burn patients, **JTTS burn sheet initiated**.)
	3. Ventilator switched to PMI vent at least 20-30 min prior to flight and set with transfer settings ordered by physician.
	4. IV / IO access verified, patent, and secured.
	5. Arterial line inserted and secured, if indicated. Transducer accessible.
	6. Ventilator tubing checked to be free from obstruction, with $ETCO_2$ and secondary lines attached.
	7. Orogastric or nasogastric tube is inserted (unless contraindicated), placement verified with chest x-ray, and attached to low-intermittent suction.
	8. Chest tubes to water seal/suction (place Heimlich valve for non-atrium chest drainage systems).
	9. Wound vacuum disconnected and stowed.
	10. Foley catheter secured, urine output measured and documented.
	Equipment, Medication, Chart, and Personnel Preparation:
	11. Medications needed for flight prepared and organized.
	12. Flight equipment bag obtained and checked. Backup pulse oximeter readily available.
	13. Complete chart photocopied (including x-ray cd), patient belongings bagged and tagged. Transfer Document, or other theater / unit approved transfer document, has been initiated.
	14. Earplugs and eye protection for patient and flight nurse.
	15. If facility sends medical attendant, attendant must have relevant personal protective equipment. In a combat environment this includes: Uniform, Kevlar, IBA, Weapon, ID Card, and equipment for transport.
	Ventilator Management:
	16. Blood gas (preferably ABG) obtained, 15 min after initial settings and ventilator changes. All efforts will be made to have a documented blood gas within 30 minutes prior to flight time.
	17. Adjust ventilator settings and check O_2 tank for length of flight. Resuscitator bag under patient's head with tubing connected to O_2 source, vent tubing free from obstruction.
	Final Verification:
	18. Transferring Physician, Flight Paramedic, ECCN (or Flight Provider) verbally agrees to flight care plan.
	19. Critical Care Transfer Orders reviewed and signed by transferring physician. **(STANDARD ORDER SET for CRITICAL CARE TRANSFERS)**
	20. Enroute CC Transfer Document with completed preflight and enroute care data handed over to and confirmed by receiving provider / facility. **(CENTCOM Transfer Document)**

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Invasive Fungal Infection in War Wounds

Provide guidance on the recognition and comprehensive management of invasive fungal infection (IFI) in war wounds.

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SUMMARY OF CHANGES

1. Updates to IFI wound epidemiology to include surgical and wound healing outcomes
2. Addition of pan-fungal PCR as a potential rapid molecular diagnostic modality
3. Updates on the use of IV voriconazole in those with impaired renal function
4. Updates on posaconazole administration
5. Addition of isavuconazole as a mold active triazole
6. Addition of tissue sample handling considerations to increase culture yield of fungi (i.e. Mucor)
7. Updated Jul 2021 with the Dakin's half-strength solution

BACKGROUND

Clinically significant infections, including invasive fungal wound infections (IFIs), have occurred in the DoD's wounded warrior patient population since the beginning of the current conflicts in Iraq and Afghanistan. During 2009-2010, a substantial increase in the incidence of IFIs was observed among military personnel with wounds sustained in Afghanistan, corresponding to a greater frequency of improvised explosive device blast injuries sustained while on foot patrol in Helmand and Kandahar provinces.[1-3] Mold contamination of the wounds was associated with regions in southern Afghanistan characterized by lower elevation, warmer temperatures,[4] and followed waterways. Of particular clinical concern was an apparent association between patient outcome and the presence of angioinvasive filamentous fungi (e.g., order Mucorales, Aspergillus species, and Fusarium species) often called "molds."[5,6] In general, IFIs are devastating infections associated with increased mortality, morbidity, limb loss, and prolonged hospitalization for survivors.[2,7-10] In civilian literature, mortality rates have been reported as high as 38%.[5] Among the military population, the crude mortality rate was as high as 8% during the first two years of increased prevalence.[11] Dismounted blast injuries were highly contaminated with debris (e.g., soil, plant matter, and shrapnel) and coinfection with bacteria and other fungi was common.[12-14]

Following recognition of the high number of IFI cases, the Joint Trauma System, in collaboration with the Uniformed Services University of the Health Sciences Infectious Disease Clinical Research Program (IDCRP) Trauma Infectious Disease Outcomes Study (TIDOS), launched an outbreak investigation. Review of the findings demonstrated that the most common mechanistic and clinical factors associated with IFI included dismounted blast injury, above-knee traumatic amputations, extensive perineal/pelvic injury (observed trend, but not statistically significant), and massive packed red blood cell transfusion (≥20 units in the first 24 hours).[1,2] Importantly, all IFI patients had a suspicious wound (i.e. unhealthy appearance), defined as recurrent tissue necrosis following at least two surgical debridements. Additional work on IFI classification emphasizes the temporal relationship between surgical findings and laboratory evidence of IFI. (See Appendix A: Examples of Suspicious Wounds.)[15]

The morbidity associated with IFI in war wounds, which may include significant tissue loss, necessitates early surgical and antifungal treatment of patients identified as high risk. Early and aggressive debridement of devitalized tissue and removal of debris are universally accepted as the most important interventions. Patients frequently require surgical amputations and/or amputation revisions, which include extending to more proximal levels (e.g., transtibial to transfemoral or transfemoral to proximal transfemoral, hip disarticulation, or hemipelvectomy.[16] IFI wounds with order Mucorales and Gram-negative bacterial co-infections were observed to have longer time to wound closure, highlighting the need for antifungal and antibacterial therapy.[14]

Early and aggressive debridement of devitalized tissue and removal of debris are universally accepted as the most important interventions.

The 3 main principles of IFI treatment:

1. Surgical debridement of infected tissue;
2. Minimization of immunosuppression (e.g., avoidance of malnutrition or excessive blood product transfusion); and
3. Utilization of empiric dual antifungal medications (e.g., amphotericin B and a broad-spectrum triazole agent) when there is a strong suspicion of an IFI.[9]

Wounds with IFI require a significantly higher number of surgical (not bedside) debridement compared to other wound infections. There are also more changes in amputation level (e.g., revision of a transfemoral amputation to either a hemipelvectomy or hip disarticulation); longer duration following injury to wound closure; and an increased frequency of return to the operating room after wound closure due to infectious complications or drainage.[12] The role of topical antifungal therapy in the prevention of IFI is not clear, but topical therapies have not been demonstrated to have adverse local or systemic effects.

EVALUATION AND TREATMENT

The most important aspect of evaluation and treatment of war wounds is a high index of suspicion for fungal infection, with the early recognition of unhealthy or suspicious wounds followed by early, aggressive, and repetitive surgical debridement of all devitalized tissue and organic material.

After initial debridement, risk factors for invasive fungal infection will be assessed. Identified risk factors include:

- Dismounted blast injury.
- Above-knee immediate traumatic amputation, or progressive transition from below-knee to through-knee to above-knee amputation.
- Extensive perineal, genitourinary, and/or rectal injury.
- Massive transfusion > 20 units packed red blood cells within 24 hours of injury.
- Extensive deep-partial-thickness or full-thickness burns (note: covered elsewhere).[17]

DIAGNOSIS CRITERIA

Diagnostic criteria for an IFI are:

1. Presence of a traumatic wound(s).
2. Recurrent necrosis following at least two consecutive surgical debridements.
3. Laboratory evidence of fungal infection following at least two surgical debridements (i.e. mold culture positivity and/or histopathology indicating tissue invasion).[9,15] This is usually not available at deployed Role 2 or Role 3 Military Treatment Facilities (MTFs), so clinical suspicion is key to early intervention.
4. Fungal wound infection is often manifested by 'tinctorial' or color changes in a wound; early detection of such changes requires repeated inspection by an experienced clinician.[18]
5. IFIs are often diagnosed through routine histopathological examination of tissue specimens. The evaluation of the performance of periodic acid-Schiff (PAS) and Gomori methenamine silver (GMS) in combat trauma-associated IFI demonstrated that the two stains were 84% concordant with false negative rates of 44% for PAS and 15% for GMS; however, neither stain was significantly superior at identifying fungal elements. Overall, there is no added benefit for increasing diagnostic yield with use of both stains.[19]
6. Where available, pan-fungal PCR, for identification of filamentous fungi evaluation offers promise for rapid identification of IFI which can lead to a more timely and accurate diagnosis.

Compared to histopathology, panfungal PCR was specific (99%), but not as sensitive (63%); however, sensitivity improved to 83% in specimens from sites with angioinvasion.[19]

TOPICAL TREATMENT

Initiate topical antifungal therapy on patients with at least three of the above risk factors above in Evaluation and Treatment.[20,22] There is no clear evidence that any topical treatment improves outcomes; however, Dakin's Solution is commonly used. Dakin's used an irrigation solution, which is how it was originally described for use, is likely beneficial for severe infections, including fungal infections. Use Dakin's solution in lieu of saline irrigations for patients meeting criteria.[23,24]

In terms of wound dressings in patients with concern for IFI, nothing has been definitively proven to improve outcomes, but using a topical antifungal is still conditionally recommended. Options include Dakin's-soaked Kerlix dressings, Silver Nitrate Solution, or honey[20,22-28] VAC (negative pressure wound dressings) are not recommended early in the treatment of IFI, or suspected IFI, because daily trips to the operating room are needed for debridement/washout, diagnostics, and source control.

Use of Dakin's solution in the prevention or treatment of IFI, though widespread and probably superior to saline or dry gauze, is unproven. At the US Army Burn Center, a 0.5% aqueous solution of silver nitrate, rather than Dakin's solution, is the preferred treatment for open wounds at risk of IFI. Established IFIs may be treated with topical Nystatin powder. Topical Silver Nitrate is not always available in the deployed environment.[29]

A standardized operative note for wound description is available and should be used throughout the continuum of care for patients at increased risk for IFI. Utilization of this operative note may facilitate the early detection of sequential wound necrosis , which is the crucial first sign of IFI – Appendix B. Description of Bastion Classification of lower limb injuries is presented in Appendix C. Document on the first page of the Operative Note.

DEBRIDEMENT AND ANTIFUNGAL THERAPY

1. For patients transferred to any Role 3 strategic evacuation hub, risk factors for IFI should be assessed and ongoing resuscitation requirements should be addressed as needed. The patient should undergo surgical examination, wound washout, and debridement (if indicated) within 6-12 hours of arrival. Dakin's wound irrigations and topical antifungal treatments as described above should be initiated/continued.
2. Evacuation should be deferred in patients who are clinically unstable and require debridement / wound care every 6-12 hours. Reassess patient to meet evacuation criteria every 24 hours. The surgeon on call should be contacted to evaluate the patient and their wounds immediately on arrival to the next level of care.
3. Upon arrival to the Role 4 MTF (i.e. regional treatment facility outside of the combat zone, but prior to arrival in the United States), the patient should undergo operative exploration, wound washout, and debridement (as indicated) within 6-12 hours. Obtain histopathology and microbiology specimens on all patients with at least three risk factors for IFI and any with clinical suspicion. Topical antifungal therapy should be continued.
4. Upon arrival to an MTF in the United States, the patient should undergo surgical exploration, wound washout, and debridement within 6-12 hours. Obtain histopathology and microbiology

specimens on all patients with at least three risk factors for IFI and/or who have an unhealthy wound appearance (e.g., tissue necrosis). Topical antifungal dressings may be discontinued at any level of care when the treating surgeon observes healthy granulation, or when histopathology and cultures are negative for fungal infection or colonization.

5. Following the first two debridements in theater, if tissue necrosis is observed in wounds after two consecutive debridements, start broad-spectrum antifungal and antibiotic medications immediately and obtain infectious disease consultation. Liposomal amphotericin B is the primary choice due to its effectiveness against mucormycosis, and its reduced potential to induce nephrotoxicity compared to the non-liposomal formulation.[30] Although voriconazole is ineffective against mucormycosis, it has shown to be an active agent against molds that are resistant to amphotericin B (e.g., *Aspergillus terreus* and *Scedosporium prolificans*).[31]
6. In general, patients with IFI are severely injured, and intravenous formulations of antifungal agents are prescribed due to concern for inadequate gastrointestinal antifungal absorption in the septic patient. As soon as feasible, parameters for monitoring antifungal drug toxicities should be implemented (EKG, renal function and LFTs).
7. When voriconazole is administered intravenously, it requires a solubilizing excipient (i.e. sulfobutyl ether β-cyclodextrin), which may accumulate in patients with impaired renal function. A black box warning has been issued due to adverse effects of the accumulating solute in an animal model. Nevertheless, the effects of elevated sulfobutyl ether β-cyclodextrin are unknown in humans.[32] An IV route of administration of voriconazole did not predict worsening renal dysfunction in a small retrospective study with the caveat that only a few patients received voriconazole for ≥ 7 days.[33] Clinical experience to date has not shown permanent renal impairment with this off-label use of voriconazole in the wounded military population.[34]
8. Posaconazole is another triazole agent that has been found to have a 60-70% response rate as a salvage regimen against mucormycosis when prescribed orally.[35-37] Posaconazole tablets are preferred over oral suspension as there is less variability in absorption. Therapeutic drug monitoring should be used if available to achieve trough concentrations > 1.0 µg/mL.[38] Recently, an intravenous formulation was approved and has shown to be useful.[39]

> The recommended dose of posaconazole (tablet formulation) is 300mg by mouth every 12 hours for 2 doses, then 300mg once daily. A posaconazole trough should be obtained on day 7 of therapy. Note that if other formulations of posaconazole are used, the dosing will be different.
>
> The typical starting dose of voriconazole is 6 mg / kg IV every 12 hours for 2 doses, followed by 4 mg/ kg (the patient's actual body weight should be used for dosing). A voriconazole trough should be obtained on day 4 of therapy. Goal trough is 1 - 1.5 mcg / mL.

9. Dual administration of liposomal amphotericin B and a broad-spectrum triazole is recommended as the first-line antifungal agents. Among triazoles, clinical experience has been primarily with voriconazole. Many of the wounds incurred by combat casualties grow more than one mold.[32] Furthermore, prescribe broad-spectrum antibiotics covering both gram-positive and gram-negative organisms (e.g., vancomycin and meropenem)are prescribed as fungal-infected wounds frequently also have bacterial growth

   Initial studies have shown that combat IFI wound cultures growing order Mucorales will have a second non-Mucorales fungus present 30% of the time. Aspergillus species is more difficult to

grow than order Mucorales but should be suspected and empirically treated initially as it has been shown to be virulent in this patient population.[40] Therefore, dual use of a broad-spectrum triazole and liposomal amphotericin B is suggested for wounds infected with either or both of these fungi. If long-term treatment is required, the antifungal medications should be targeted based on culture results.

10. Isavuconazole is a triazole agent available in IV and oral formulations with mold activity including against mucormycosis. Isavuconazole has not been studied in randomized controlled trials but in one multicenter open-label single-arm study, isavuconazole demonstrated similar efficacy to amphotericin B formulations in an external matched control group.[40]
11. Particular attention should be given to aggressive debridement of non-viable tissue at each debridement procedure. The extent of necrosis and appearance of the wound before and after completion of the operation should be documented in the operative note. Appendix B shows a standardized operative note for wound description to be used for patients at increased risk for IFI. Whenever a significant amount of necrotic tissue is debrided, repeat debridement should be performed in 24 hours or less.

    As aggressive surgical debridement of all necrotic and infected tissue remains the mainstay of treatment for IFI, surgical exploration and debridement should continue at least every 24 hours until cessation of necrosis occurs. Wound coverage and closure should not occur until after the wound is clean, contracting, and granulating.
12. If angioinvasive fungal elements or fungal elements among tissue are reported on histopathology, or if cultures are positive in the setting of recurrent necrosis, initiate (or continue) treatment with systemic antifungal medications. Treatment will require close consultation with infectious disease; however, as a general guideline, stop systemic antifungal medications if the wound remains clean/viable for two weeks and if the patient remains clinically stable. If the patient has a fungal infection in more than one body region (e.g., extremity/pelvis, abdomen, and chest), long-term treatment may be indicated.

BIOPSY AND TISSUE CULTURE IN OR

Biopsy should be done at the time of wound exploration (after initial surgical debridement) once the casualty has been evacuated from the theater of conflict (in theater if patient evacuation is delayed) and repeated on subsequent explorations if there are persistent findings (e.g., sepsis physiology, wound necrosis) raising suspicion for IFI.

1. Tissue samples should be obtained from each lower extremity in patients with bilateral lower extremity amputations. Sample all suspected areas.
2. Other sites sampled should be at the discretion of the operative surgeon.
3. At least one specimen should be taken from the junction of viable and necrotic tissue (the last piece of borderline-viable tissue removed).
4. For each site sampled, two tissue samples will be collected fresh in two separate sterile specimen containers.
    - One specimen (1 cm3) for “rush” histopathological examination
    - One specimen (1 cm3) for fungal and bacterial culture

OR STAFF RESPONSIBILITIES

The histopathology specimen is placed in formalin. It is not necessary to send fresh samples.

Order histopathology and cultures (aerobic, anaerobic, and fungal). Special studies are not routinely done, but may be requested (e.g., mycobacterial and viral).

1. Clearly label specimens. Labels contain the following information:
   - Site (e.g., left lower extremity)
   - Patient's name, date of birth, and hospital identification number
   - Date and time obtained
   - "Rush" sticker if available
   - Initials of the person labelling the container
2. Directly contact the on-call pathologist to let them know they will receive a "rush" histopathology specimen for IFI shortly. Deliver the histopathology specimen to the pathology lab immediately.

PATHOLOGY STAFF RESPONSIBILITIES

Pathology staff will coordinate processing as rapidly as possible (≤ 24 hours).

1. Histopathological specimen will be stained with hematoxylin and eosin (H&E) and GMS/PAS stains and evaluated for (1) presence of fungal elements; (2) presence of fungal elements in viable or non-viable tissue; (3) presence of angioinvasion.
2. Microbiological specimen will be cultured for aerobes, anaerobes, and fungi.
3. Mycobacterial and/or viral cultures will not be done routinely under this protocol but may be done with special request.

NOTE:
Fungus can take up to six weeks to grow in culture medium. Therefore, it is recommended that the cultures be checked frequently for two weeks; then once a week for four additional weeks before they are considered final. In addition, wounds without recurrent tissue necrosis may have mold colonization and not a true infection.[41]
Tissue preparation for culturing typically destroys the ribbon-like hyphal elements of fungi belonging to the order Mucorales, reducing growth. The microbiology laboratory should be notified that an IFI is suspected so samples are handled appropriately to maximize culture yield.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- Identify patients with IFI
- Patients with 3 or more risk factors for invasive fungal infection (dismounted blast, above knee amputation, perineal genitourinary or rectal injury, MT> 20 units RBC + WB within 24h of injury.)

INTENT (EXPECTED OUTCOMES)

- Patients with ≥3 IFI risk factors undergo surgical debridement undergo surgical debridement in the OR within 6-12 hours of arrival at Role 3 or 4 MTFs.
- Patients with ≥3 IFI risk factors and wounds concerning for IFI are:
  - taken to the OR at least every 24 hours
  - are started on IV or PO antifungals.
- An operative note for wound debridement includes the extent of necrosis quantified as a percentage of each wound.

PERFORMANCE/ADHERENCE METRICS

- Number and percentage of patients in the population of interest who undergo surgical debridement in the OR within 6-12 hours of arrival at Role 3 or 4 MTFs.
- Number and percentage of patients in the population of interest who have an operative note that quantifies the extent of wound necrosis as a percentage of each wound.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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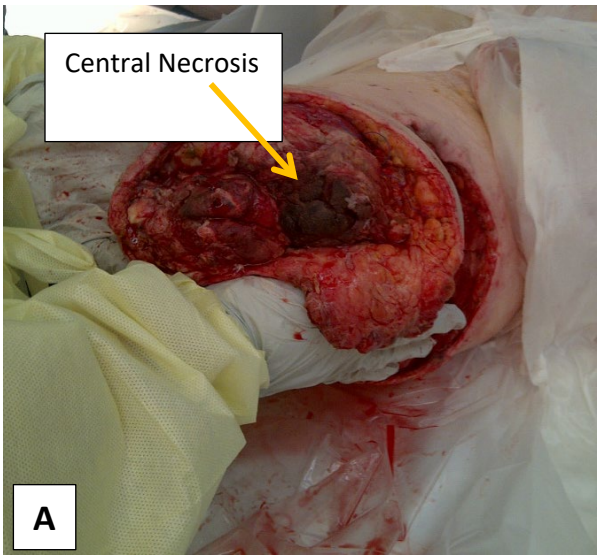
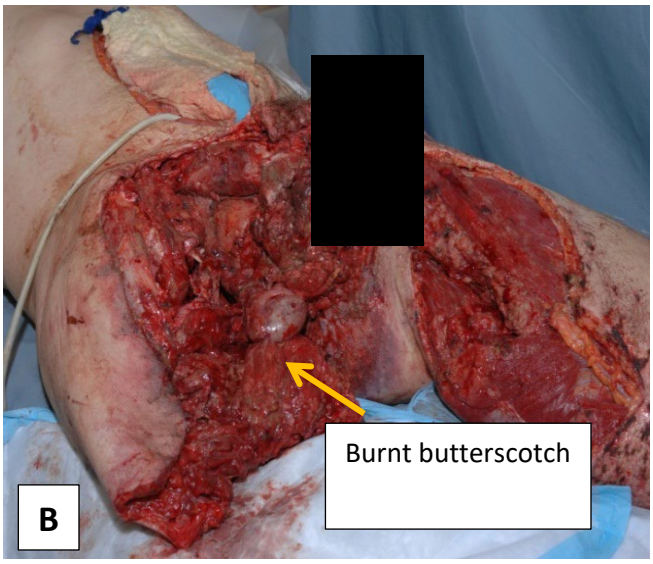
APPENDIX A: EXAMPLES OF SUSPICIOUS WOUNDS

All photos are from different patients.

(A) Patient is 8 days out from injury. His wound is showing central necrosis. Debridement day prior revealed healthy appearing, bleeding tissue.

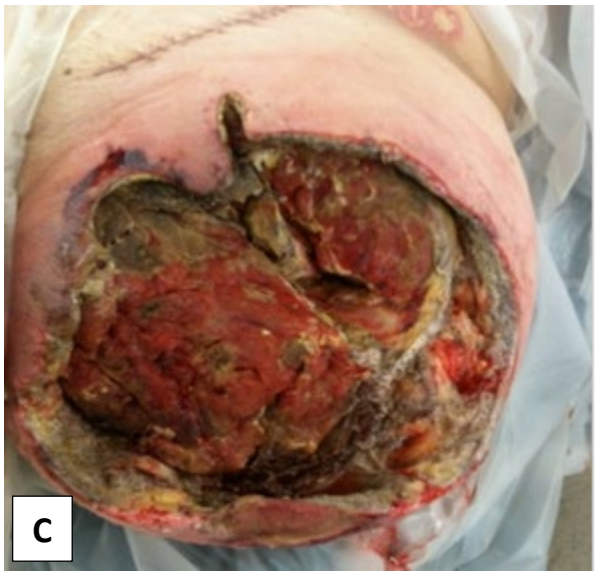
(B) Patient is also 8 days out from injury. Patchy necrosis is seen throughout his right-sided hemipelvectomy. Upon closer inspection, one notices a 'burnt butterscotch' appearance overlying tissue. Anecdotally, this is an additional IFI clinical indicator.

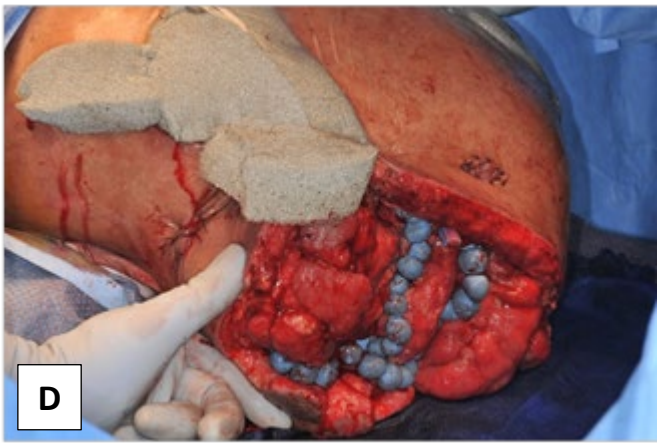




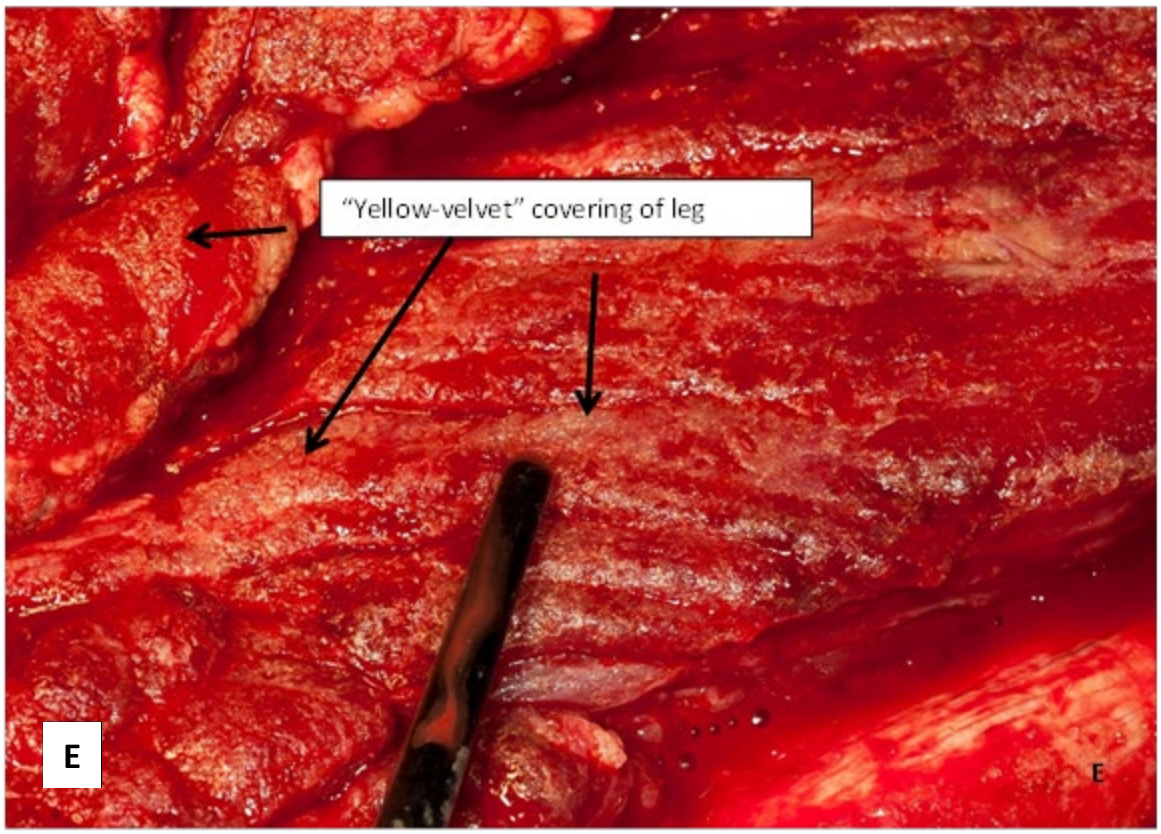
(C) Provides example of tissue necrosis in a previously healthy-appearing wound bed.

(D) Patient is recovering well, but still being treated with anti-microbial beads





(E) Looking closely at the wound, one can see a 'yellow-velvet' covering to the wound. This is indicative of an Aspergillus infection.



APPENDIX B: MD TRAUMA WOUND DEBRIDEMENT OP NOTE

MD TRAUMA WOUND DEBRIDEMENT OP NOTE	
Date of Operation:	
Pre-Operative Diagnosis:	
Post-Operative Diagnosis:	
Initial Bastion Amputation Class:	**1** (foot) **2** (below knee) **3** (above knee) **4** (proximal thigh) **5** (involves buttock/perineum)
Surgeon(s):	
Anesthesia:	
EBL:	
Fluids/Blood Products Administered:	
OPERATIVE SITE #1: (specify)	
Procedure Initial amputation (level) _____ Revision amputation (level) _____ Debridement/Washout Number_____ DPC Exam/Dressing change under Anesthesia Ex-Fix (initial) Ex-Fix (revision) ORIF Orthopedic hardware removal Other_____	**Wound Description** Total size of wound:_____cm^2 Clean Approx 25% necrotic Approx 50% necrotic Approx 75% necrotic Completely necrotic Grossly purulent Gross mold
Samples Sent None Aerobic culture Anaerobic culture Fungal culture Histopathology Other_____	**Adjunctive Therapy** Antimicrobial beads (type) _____ Dakin's-soaked dressings Dakin's Instill Device (started) Dakin's Instill Device (Renewed) Negative pressure therapy Other_____
Comments:	

MD Trauma Wound Debridement Op Note

OPERATIVE SITE #2: (specify)

Procedure	**Wound Description**
Initial amputation (level) _____	
Revision amputation (level) _____	Total size of wound:_____cm^2
Debridement/Washout Number_____	Clean
DPC	Approx 25% necrotic
Exam/Dressing change under Anesthesia	Approx 50% necrotic
Ex-Fix (initial)	Approx 75% necrotic
Ex-Fix (revision)	Completely necrotic
ORIF	Grossly purulent
Orthopedic hardware removal	Gross mold
Other_____	
Samples Sent	**Adjunctive Therapy**
None	Antimicrobial beads (type) _____
Aerobic culture	Dakin's-soaked dressings
Anaerobic culture	Dakin's Instill Device (started)
Fungal culture	Dakin's Instill Device (Renewed)
Histopathology	Negative pressure therapy
Other_____	Other_____
Comments:	

OPERATIVE SITE #3: (specify)

Procedure	**Wound Description**
Initial amputation (level) _____	
Revision amputation (level) _____	Total size of wound:_____cm^2
Debridement/Washout Number_____	Clean
DPC	Approx 25% necrotic
Exam/Dressing change under Anesthesia	Approx 50% necrotic
Ex-Fix (initial)	Approx 75% necrotic
Ex-Fix (revision)	Completely necrotic
ORIF	Grossly purulent
Orthopedic hardware removal	Gross mold
Other_____	
Samples Sent	**Adjunctive Therapy**
None	Antimicrobial beads (type) _____
Aerobic culture	Dakin's-soaked dressings
Anaerobic culture	Dakin's Instill Device (started)
Fungal culture	Dakin's Instill Device (Renewed)
Histopathology	Negative pressure therapy
Other_____	Other_____
Comments:	

APPENDIX C: BASTION CLASSIFICATION OF LOWER LIMB INJURY

BASTION CLASSIFICATION OF LOWER LIMB INJURY CAUSED BY IED. THE MOST PROXIMAL EXTENT.	
Class of limb injury	**Description**
1	Injury confined to foot
2	Injury involving lower leg permitting effective below-knee tourniquet application
3	Injury involving proximal lower leg or thigh, permitting effective above-knee tourniquet application
4	Proximal thigh injury, preventing effective tourniquet application
5	Any injury with buttock involvement

Reference: Jacobs N, Rourke K, Rutherford J, et al. Lower limb injuries caused by improvised explosive devices: proposed 'Bastion classification' and prospective validation. Injury 2014; 45(9): 1422-28.

APPENDIX D: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

JTS CPG Development Process (CPG ID:54)

This CPG describes the current processes and procedures for CPG development, periodic review/update, verification, and publication.

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SUMMARY OF CHANGES

1. The Defense Committee on Trauma (DCoT) will now oversee the CPG process.
2. CPG approval process will start with DCoT Chief, Performance Improvement (PI) Chief and JTS Chief.
3. CPG process has been updated to add the role of the CPG manager who will track and coordinate CPG process with the lead author.
4. Submit CPG topic ideas, corrections, and questions to dha.jbsa.healthcare-ops.list.jts-cpg@health.mil

INTRODUCTION

The JTS CPGs were developed out of necessity to reduce variability in care, improve quality, measure outcomes, and weigh the benefits against the risks and costs of specific interventions. These CPGs provide recommendations to deployed clinicians about the care of trauma patients with specific conditions and are not a substitute for clinical judgment. The CPGs were developed through evidence-based research, systematic review of the literature, PI indicators and input from Subject Matter Experts (SMEs).

BACKGROUND

CPGs are "statements that include recommendations intended to optimize patient care that are informed by a systematic review of evidence and an assessment of the benefits and harms of alternative care options."[1] To date, over 80 CPGs have been instituted to inform the standard of care for the US military in the deployed setting and are reflective of the current "state of the art" at the time of release.

CPGs are developed based on the best available evidence and SME consensus, providing clinicians with recommendations to improve the quality of care, standardization of care and serve as an educational resource while deployed. A systematic and operationally responsive approach to development, verification and implementation of CPGs is taken to ensure rapid field dissemination and provide quality indicators to measure effectiveness. Department of Defense (DoD) trauma cases worldwide are reviewed for CPG compliance by JTS in accordance with PI metrics specified at the end of each CPG.

JTS guidelines may be updated frequently based on operational need and clinical observations and have all been written by SME volunteers. CPGs undergo revisions when the clinical or operational need arises. The JTS CPGs currently do not meet the National Academies of Sciences Engineering and Medicine standards for CPG development[1] to facilitate expediency, responsiveness to the military operational environment and rapid performance improvement. In some cases, there may be little published literature (military or civilian) to guide battlefield or operational medicine, requiring heavy reliance on SME opinion or unpublished analysis of military data. JTS CPGs are timely and reflect evolving threats, technologies, and current realities on the battlefield. The JTS recommends every deploying clinician in their respective Combatant Command (CCMD) who will be providing care for casualties becomes familiar with the CPGs posted on the JTS website.

Strong evidence demonstrates CPG compliance is associated with a reduction in mortality.[2-4] The Donabedian Model for quality improvement in health care states that, besides patient characteristics,

institutional structures and clinical practices determine patient outcome.[5] Evidence-based CPGs are developed to avoid unnecessary variation and promote consistency in healthcare practice throughout the continuum of care to achieve optimal outcomes. JTS CPGs complement the deployed PI process. Since the early days of the U.S. Central Command (USCENTCOM) trauma system, the guidelines have been developed and implemented by clinical SMEs in response to needs identified in the CCMD Area of Operations (AOR). More recently, as the trauma system has matured, the process for identifying, developing, vetting, approving, and implementing CPGs has also matured.

To the greatest extent possible, JTS CPGs are evidence-based. The evidence is derived from the published literature, to include analysis of combat casualty data. When evidence is lacking or unclear, yet a CPG is needed, guidelines are developed based on the best available evidence and SME consensus. In order to ensure CPGs include the latest techniques and innovations, monitoring of all CPGs is essential. To ensure monitoring, each individual CPG will include a system-level PI monitoring plan. Monitoring specifics (e.g., timing, frequency, performance measures) are written in the PI monitoring plan for each CPG. This system-wide monitoring will be conducted by the JTS PI Branch. The PI plan will state the intent and minimum performance measures that will be utilized for monitoring. Trauma directors or their equivalents at the deployed military treatment facility level are expected to implement local PI processes to ensure appropriate adherence to the CPGs; the PI monitoring plan will help guide these efforts. Routine updates to CPGs occur every five years or as the operational need arises or as new evidence surfaces. SMEs include, but are not limited to, military and DoD civilian experts, deployed clinicians, Service specialty consultants, trauma medical directors, trauma program managers, JTS Branch Chiefs, and trauma PI nurse analysts.

Although the JTS CPGs were originally developed for USCENTCOM, they are no longer specific to any particular CCMD or contingency. JTS CPGs are patient-centric guidelines with the intent of keeping the medicine joint and agnostic of Service or location. Because CCMDs greatly differ in climate, terrain, and resources, the JTS CPGs are not representative of a specific CCMD or contingency. Services, unit organizations, and trauma directors may tailor to unit missions, deployed settings, and unique situations.

CPG DEVELOPMENT

TOPIC IDENTIFICATION

Any DoD Service Member can propose a topic for CPG development or revision to the JTS CPG Manager. (See Appendices A-C for process flow charts.) At a minimum, a new CPG topic must include:

- A description of the proposed guideline and perceived gap in care.
- Identification of end-users of the guideline.
- Identification of changes in performance to be driven by the guideline.

TOPIC SELECTION

The JTS clinical leadership (DCoT Chief, DCoT Committee Chairs, PI Chief, and JTS Chief will determine the need for the proposed CPG topic based on:

1. Relevance to the deployed combat casualty environment
2. Potential for reduction of clinically significant variations

3. Incidence, prevalence, or trend identified by DoD Trauma Registry data
4. Evolution of best practices
5. Findings and implementation of lessons learned
6. Requests from theater/CCMD/Service
7. Target audience of CPG (prehospital, en route care, role 2/3)

Submit CPG topic recommendations to: dha.jbsa.healthcare-ops.list.jts-cpg@health.mil

KEY CPG DEVELOPMENT STEPS

Once the proposed CPG topic is approved, DCoT Committee Chair with CPG Manager will initiate the CPG process:

- Identify lead author
- Identify sponsor (generally a DCoT committee will sponsor a CPG)
- Crosswalk with other existing projects/proposals
- Provide literature review/data retrieval support as needed

CPG CONTENT REQUIREMENTS

At a minimum the CPG must contain the following:

- Summary of changes if CPG update
- Background and/or introduction
- Evaluation
- Treatment
- PI metrics (provided by PI team)
- Source references
- Credential information for working group (rank, branch of service, title (MD/DO/RN, etc.)

RESPONSIBILITIES

Title	Responsibility
DCoT Chief	Publish relevant, evidence-based CPGs with best practices.
PI Chief	Monitor global implementation and adherence to CPGs.
JTET Chief	Develop education and training content specific to CPGs.
CCMD / Theater Command Surgeon	Implement and monitor employment of CPGs in AOR.
Trauma Director	• Ensure training, mission-based compliance. • Ensure PI monitoring. • Ensure reporting at the local level.
CPG Manager	• Responsible for overseeing the entire CPG development process from concept to publication • Liaison to lead author • Liaison to PI for metrics • Liaison to DCoT • Oversees socialization of CPGs.
Technical Writer	• Edit and format CPGs. • Routes for approval to JTS Chief/Deputy Chief and DHA PAO. • Publishes CPG on the JTS website. • Uploads CPG to CPG app in JTS Manager.

CPG MANAGER

The CPG Manager will:

1. Cross reference proposals with existing CPGs.
2. Identify way ahead course of actions (COAs)
3. Present COAs to JTS clinical leadership (DCoT Chief, DCoT Committee Chairs, PI Chief, and JTS Chief) for decision.

LEAD AUTHOR

The lead author will:

1. Serve as the point person to the DCoT CPG manager throughout the entire process. (See note below.)
2. Develop an editorial working group comprised of SMEs. A working group ideally will include 5 to 10 experts representing all U.S. military services. Input from civilian and foreign military SMEs is permissible but should not substitute for U.S. tri-service input.
3. Identify and disclose any potential conflicts of interest.
4. Draft CPG structure.
5. Conduct a review of the literature.

6. Define responsibilities and development timeline.
7. Coordinate with the working group.
8. Draft CPG.
9. Coordinate with JTS PI team to establish PI metrics.
10. Identify research, development, test, and evaluation requirements.
11. Submit draft CPG to JTS CPG manager for distribution to reviewers.
12. Collate and reconcile working group and SME input.
13. Prepare final draft of proposed CPG for review.
14. Distribute the CPG proposal to the working group to create the draft CPG.
15. Review available evidence and produce a working draft of the new CPG.
16. Collate and reconcile working group and SME input.

NOTE: The JTS may identify an Academic Action Officer to assist the lead author with literature collection, literature review, and drafting CPG text.

PEER REVIEW & APPROVAL

1. Draft is received from lead author - Chiefs/Chairs will review initial draft.
2. The sponsoring Committee Chair will send the draft to one of the following for review:
   - Specified individual SMEs
   - Select committee
   - DCoT members
3. CPG manager will send draft to select committee for review and vote for approval.
4. CPG manager will send draft to DCoT members for review and vote for approval.
5. DCoT CPG manager will consolidate comments for adjudication by the lead author.
6. After the comments are adjudicated, the CPG will be sent to DCoT Chief in conjunction with PI Chief for approval.
7. The technical writer will route the final draft to the JTS Chief for approval. (The JTS Deputy Chief can sign off on the CPG for publication if the draft has been previously reviewed the Chief.)
8. Upon JTS Chief approval, the technical writer will forward the CPG to DHA for Public Affairs Office/Operations Security (PAO/OPSEC) review and approval. The approved CPG will then be published on the JTS CPG web-based platforms.
   - https://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs
   - www.deployedmedicine.com
   - Deployed Medicine mobile app

NOTE: Approval authority for implementation of the CPG in any CCMD rests with each CCMD. See Implementation of JTS CPGs below.

REVIEW & UPDATE OF EXISTING JTS CPGS

1. Existing CPGs will be revised at least every five years, or sooner in response to clinical or operational needs. (See Appendix B and Appendix C for process in flow chart.)
2. The JTS PI Branch Chief/DCoT will review each CPG to determine the need for significant revision.
   - If an update is needed, the PI Branch Chief/DCoT will initiate the update by inviting the current CPG's lead author(s) to head the revision process.
   - If the lead author has separated from the military or declines, a new lead author will be identified, and the revision process will follow that of a new CPG.
   - If no update is required as determined by the JTS PI Branch Chief/DCoT, the CPG is submitted to the JTS Chief for re-approval.
3. The JTS PI Branch Chief/DCoT will approve all proposals for rapid/routine updates, clinical enhancements, specific population, and operational considerations to an individual CPG. This approval will create an abbreviated review process for rapid update and will not affect the publication date of the CPG. (See Appendix A-C for detailed processes.) The lead author, and the editorial working group at its discretion, will review these updates for inclusion into the CPG. These updated CPGs will be forwarded to the JTS PI Branch Chief/DCoT Chair(s) for approval before sending to the JTS Chief for final approval.
4. Upon approval, the CPGs will undergo PAO/OPSEC review prior to posting on the JTS CPG webpage and Deployed Medicine.

PUBLICATION & DISSEMINATION

CPGs will be published posting on the JTS website and Deployed Medicine App. The CPG will be socialized through infographics, social media campaigns and though the weekly Combat Casualty Care Conference. See Appendix D for a list of dissemination activities.

REFERENCES

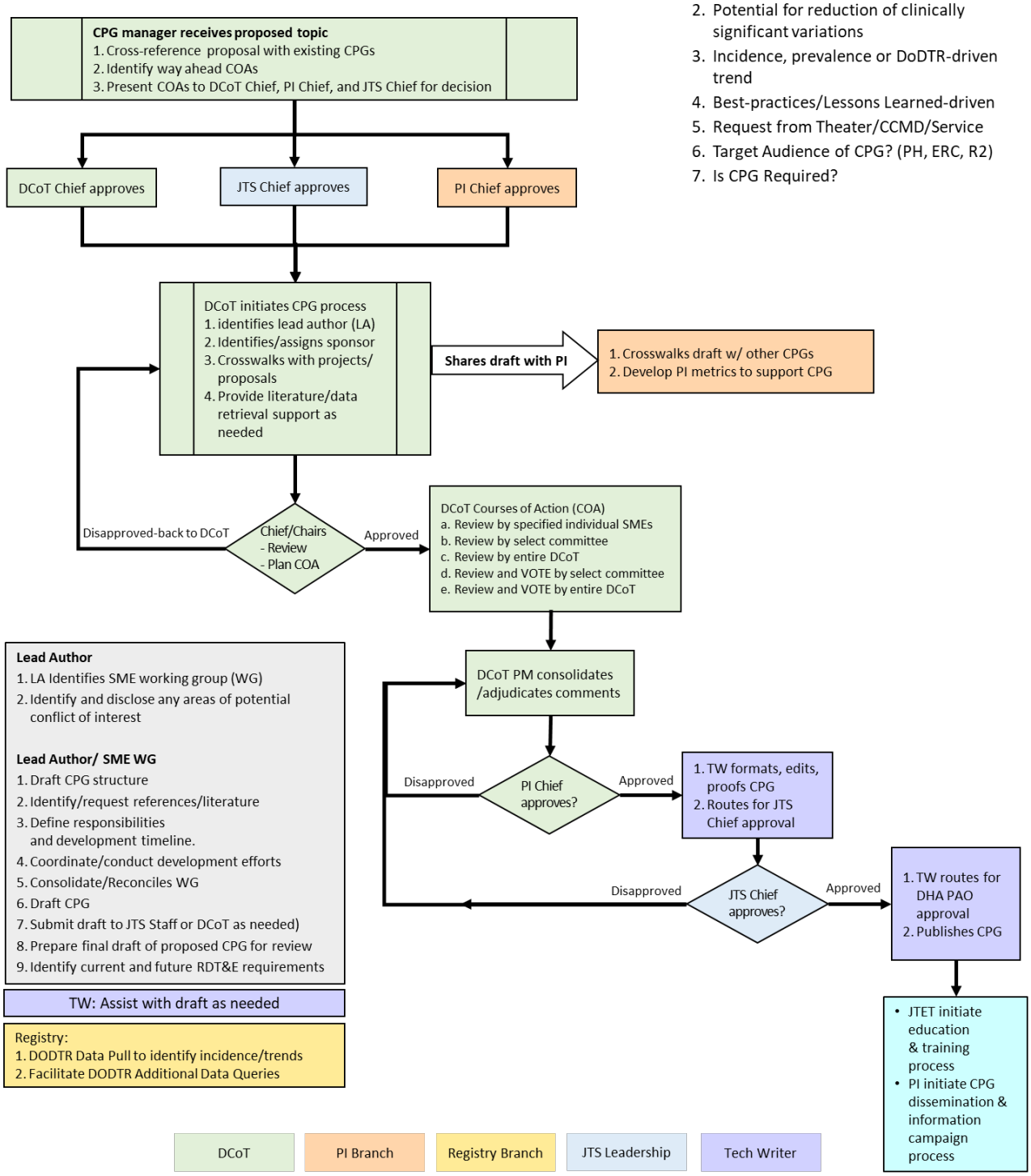
1. IOM (Institute of Medicine). Clinical practice guidelines we can trust. Washington, DC: The National Academies Press, 2011.
2. Shafi S, Barnes SA, Rayan N, et al. Compliance with recommended care at trauma centers: association with patient outcomes. J Am Coll Surg. 2014;219(2):189-98.
3. Eastridge BJ, Costanzo G, Jenkins D, et al. Impact of joint theater trauma system initiatives on battlefield injury outcomes. Am J Surg, 2009;198(6): 852-7.
4. Bailey JA, Morrison JJ, Rasmussen TE. Military trauma system in Afghanistan: lessons for civil systems? Curr Opin Crit Care, 2014;19(6):569-577.
5. Donabedian, A. The quality of care. How can it be assessed? JAMA. 1988;260:1743–1748.

APPENDIX A: NEW CPG – FULL REVIEW

New CPG – Full Review

Criteria for a CPG Development

1. Relevant to the deployed environment
2. Potential for reduction of clinically significant variations
3. Incidence, prevalence or DoDTR-driven trend
4. Best-practices/Lessons Learned-driven
5. Request from Theater/CCMD/Service
6. Target Audience of CPG? (PH, ERC, R2)
7. Is CPG Required?


CPG manager receives proposed topic
1. Cross-reference proposal with existing CPGs
2. Identify way ahead COAs
3. Present COAs to DCoT Chief, PI Chief, and JTS Chief for decision
DCoT Chief approves
JTS Chief approves
PI Chief approves
DCoT initiates CPG process
1. identifies lead author (LA)
2. Identifies/assigns sponsor
3. Crosswalks with projects/ proposals
4. Provide literature/data retrieval support as needed
Shares draft with PI
1. Crosswalks draft w/ other CPGs
2. Develop PI metrics to support CPG
Disapproved-back to DCoT
Chief/Chairs
- Review
- Plan COA
Approved
DCoT Courses of Action (COA)
a. Review by specified individual SMEs
b. Review by select committee
c. Review by entire DCoT
d. Review and VOTE by select committee
e. Review and VOTE by entire DCoT
Lead Author
1. LA Identifies SME working group (WG)
2. Identify and disclose any areas of potential conflict of interest
Lead Author/ SME WG
1. Draft CPG structure
2. Identify/request references/literature
3. Define responsibilities and development timeline.
4. Coordinate/conduct development efforts
5. Consolidate/Reconciles WG
6. Draft CPG
7. Submit draft to JTS Staff or DCoT as needed)
8. Prepare final draft of proposed CPG for review
9. Identify current and future RDT&E requirements
TW: Assist with draft as needed
Registry:
1. DODTR Data Pull to identify incidence/trends
2. Facilitate DODTR Additional Data Queries
DCoT PM consolidates /adjudicates comments
Disapproved
PI Chief approves?
Approved
1. TW formats, edits, proofs CPG
2. Routes for JTS Chief approval
Disapproved
JTS Chief approves?
Approved
1. TW routes for DHA PAO approval
2. Publishes CPG
• JTET initiate education & training process
• PI initiate CPG dissemination & information campaign process
DCoT
PI Branch
Registry Branch
JTS Leadership
Tech Writer

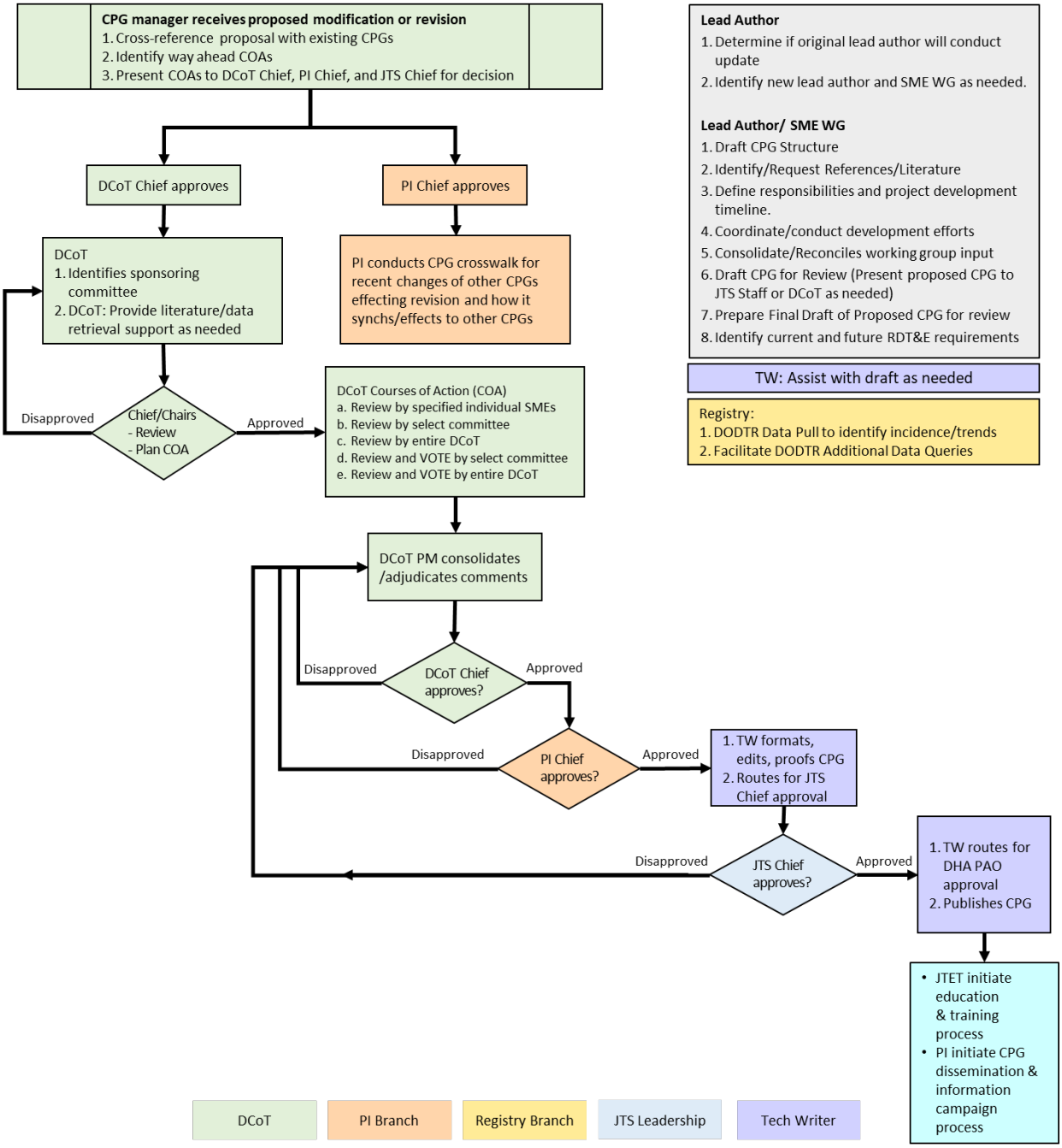
Send CPG inquiries to: dha.jbsa.healthcare-ops.list.jts-cpg@health.mil

APPENDIX B: ROUTINE CPG UPDATE

Routine CPG Update

Criteria for a Routine Update

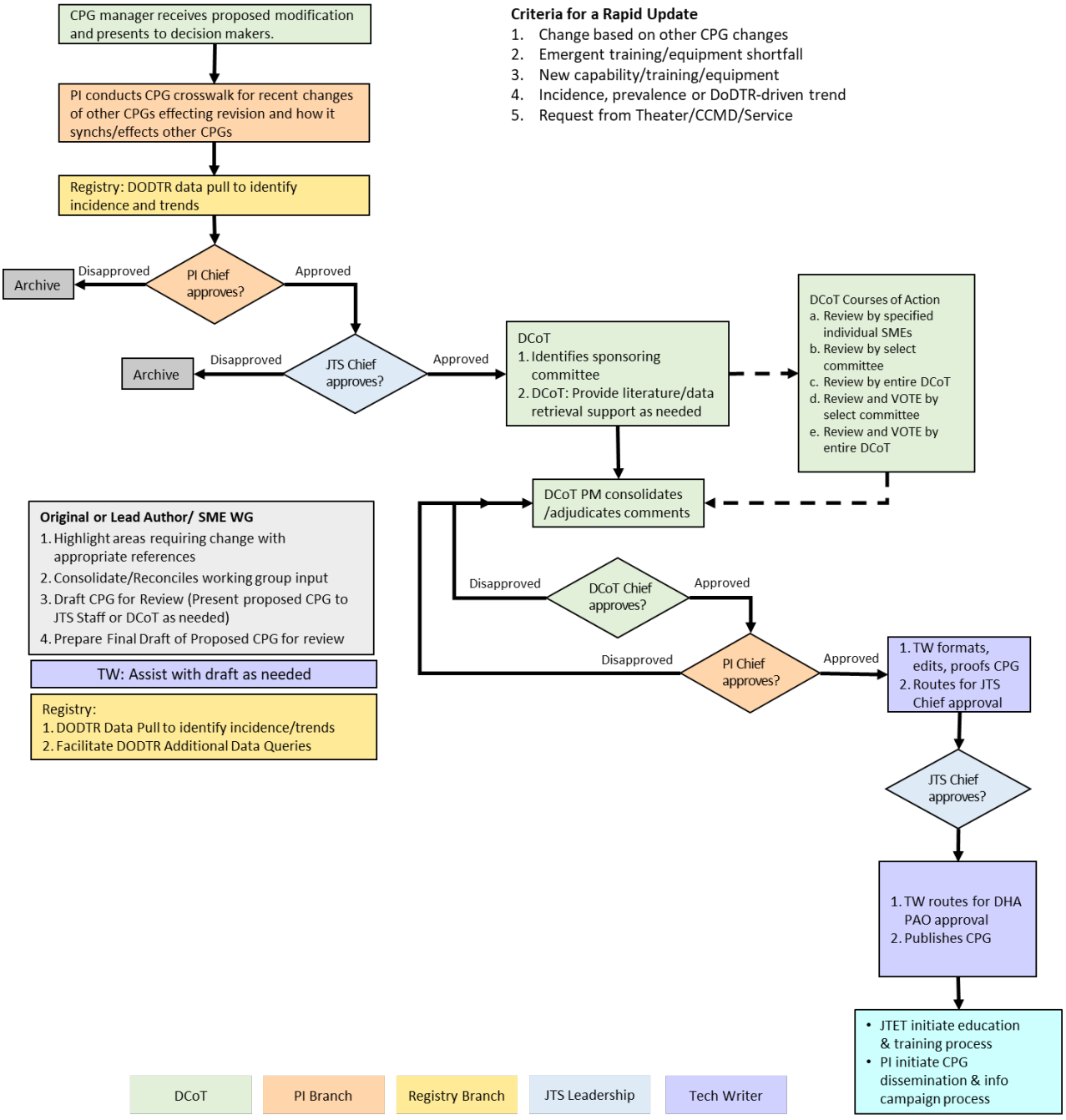
1. 3–5-year cyclic review
2. Emerging evidence
3. Changes to current practices, capabilities, or equipment
4. SME identified changes needed
5. Request from Theater/CCMD/Service
6. Is CPG Required?


CPG manager receives proposed modification or revision
1. Cross-reference proposal with existing CPGs
2. Identify way ahead COAs
3. Present COAs to DCoT Chief, PI Chief, and JTS Chief for decision
DCoT Chief approves
PI Chief approves
DCoT
1. Identifies sponsoring committee
2. DCoT: Provide literature/data retrieval support as needed
PI conducts CPG crosswalk for recent changes of other CPGs effecting revision and how it synchs/effects to other CPGs
Disapproved
Chief/Chairs
- Review
- Plan COA
Approved
DCoT Courses of Action (COA)
a. Review by specified individual SMEs
b. Review by select committee
c. Review by entire DCoT
d. Review and VOTE by select committee
e. Review and VOTE by entire DCoT
DCoT PM consolidates /adjudicates comments
Disapproved
DCoT Chief approves?
Approved
Disapproved
PI Chief approves?
Approved
1. TW formats, edits, proofs CPG
2. Routes for JTS Chief approval
Disapproved
JTS Chief approves?
Approved
1. TW routes for DHA PAO approval
2. Publishes CPG
• JTET initiate education & training process
• PI initiate CPG dissemination & information campaign process
Lead Author
1. Determine if original lead author will conduct update
2. Identify new lead author and SME WG as needed.
Lead Author/ SME WG
1. Draft CPG Structure
2. Identify/Request References/Literature
3. Define responsibilities and project development timeline.
4. Coordinate/conduct development efforts
5. Consolidate/Reconciles working group input
6. Draft CPG for Review (Present proposed CPG to JTS Staff or DCoT as needed)
7. Prepare Final Draft of Proposed CPG for review
8. Identify current and future RDT&E requirements
TW: Assist with draft as needed
Registry:
1. DODTR Data Pull to identify incidence/trends
2. Facilitate DODTR Additional Data Queries
DCoT
PI Branch
Registry Branch
JTS Leadership
Tech Writer

Send CPG inquiries to: dha.jbsa.healthcare-ops.list.jts-cpg@health.mil

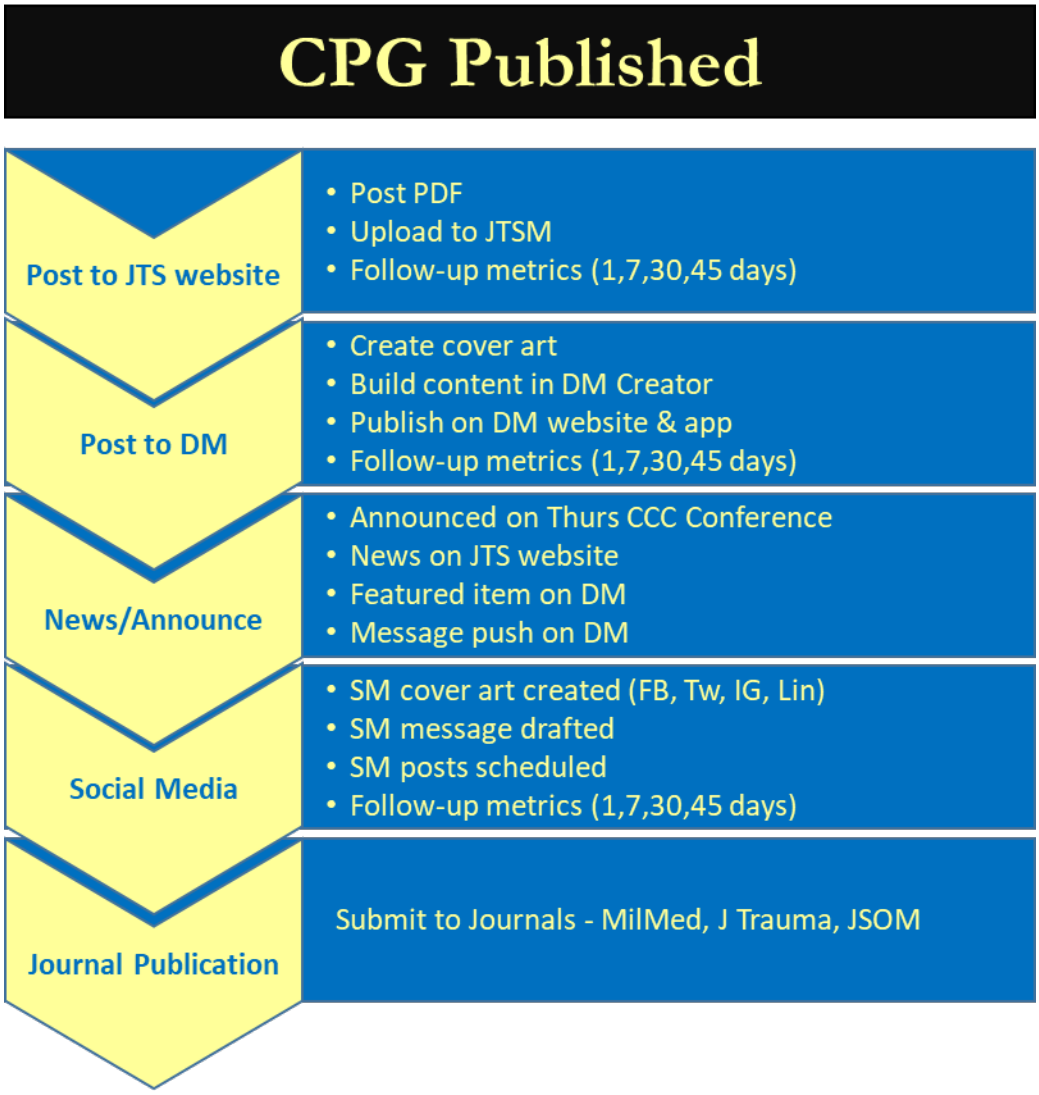
APPENDIX C: RAPID UPDATE

Rapid CPG Update

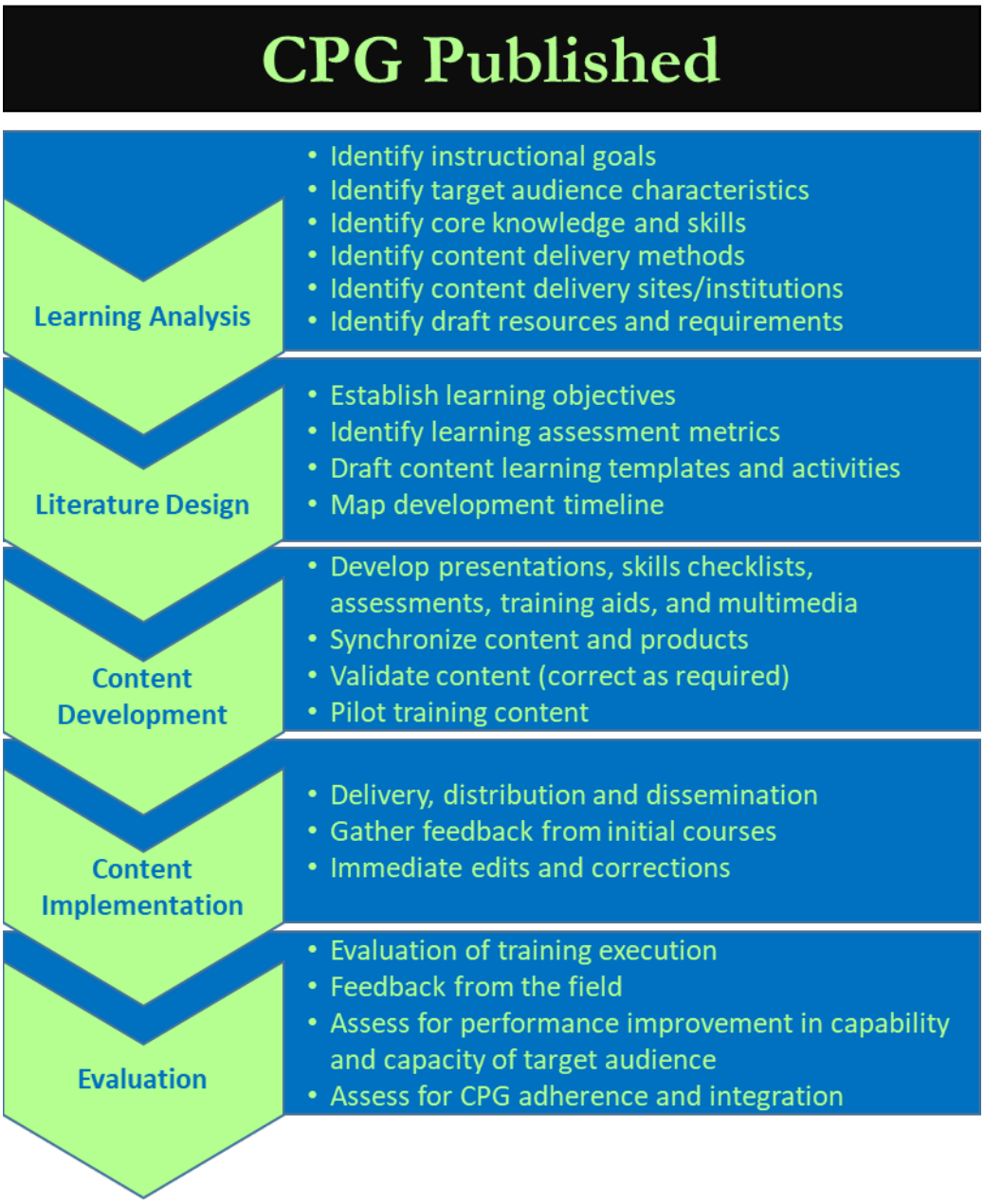

CPG manager receives proposed modification and presents to decision makers.
PI conducts CPG crosswalk for recent changes of other CPGs effecting revision and how it synchs/effects other CPGs
Registry: DODTR data pull to identify incidence and trends
PI Chief approves?
Disapproved
Archive
Approved
JTS Chief approves?
Disapproved
Archive
Approved
DCoT
1. Identifies sponsoring committee
2. DCoT: Provide literature/data retrieval support as needed
DCoT Courses of Action
a. Review by specified individual SMEs
b. Review by select committee
c. Review by entire DCoT
d. Review and VOTE by select committee
e. Review and VOTE by entire DCoT
DCoT PM consolidates /adjudicates comments
Disapproved
DCoT Chief approves?
Approved
Disapproved
PI Chief approves?
Approved
1. TW formats, edits, proofs CPG
2. Routes for JTS Chief approval
JTS Chief approves?
1. TW routes for DHA PAO approval
2. Publishes CPG
• JTET initiate education & training process
• PI initiate CPG dissemination & info campaign process
Criteria for a Rapid Update
1. Change based on other CPG changes
2. Emergent training/equipment shortfall
3. New capability/training/equipment
4. Incidence, prevalence or DoDTR-driven trend
5. Request from Theater/CCMD/Service
Original or Lead Author/ SME WG
1. Highlight areas requiring change with appropriate references
2. Consolidate/Reconciles working group input
3. Draft CPG for Review (Present proposed CPG to JTS Staff or DCoT as needed)
4. Prepare Final Draft of Proposed CPG for review
TW: Assist with draft as needed
Registry:
1. DODTR Data Pull to identify incidence/trends
2. Facilitate DODTR Additional Data Queries
DCoT
PI Branch
Registry Branch
JTS Leadership
Tech Writer

Send CPG inquiries to: dha.jbsa.healthcare-ops.list.jts-cpg@health.mil

APPENDIX D: CPG DISSEMINATION CAMPAIGN


CPG Published
Post to JTS website
• Post PDF
• Upload to JTSM
• Follow-up metrics (1,7,30,45 days)
Post to DM
• Create cover art
• Build content in DM Creator
• Publish on DM website & app
• Follow-up metrics (1,7,30,45 days)
News/Announce
• Announced on Thurs CCC Conference
• News on JTS website
• Featured item on DM
• Message push on DM
Social Media
• SM cover art created (FB, Tw, IG, Lin)
• SM message drafted
• SM posts scheduled
• Follow-up metrics (1,7,30,45 days)
Journal Publication
Submit to Journals - MilMed, J Trauma, JSOM

APPENDIX E: CPG EDUCATION CONTENT DEVELOPMENT

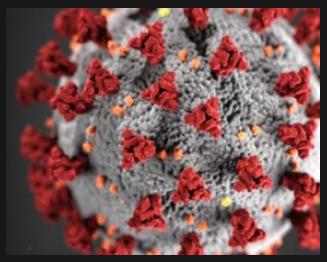

CPG Published
Learning Analysis
• Identify instructional goals
• Identify target audience characteristics
• Identify core knowledge and skills
• Identify content delivery methods
• Identify content delivery sites/institutions
• Identify draft resources and requirements
Literature Design
• Establish learning objectives
• Identify learning assessment metrics
• Draft content learning templates and activities
• Map development timeline
Content Development
• Develop presentations, skills checklists, assessments, training aids, and multimedia
• Synchronize content and products
• Validate content (correct as required)
• Pilot training content
Content Implementation
• Delivery, distribution and dissemination
• Gather feedback from initial courses
• Immediate edits and corrections
Evaluation
• Evaluation of training execution
• Feedback from the field
• Assess for performance improvement in capability and capacity of target audience
• Assess for CPG adherence and integration

Joint Trauma System Clinical Practice Guideline

Special Edition v3.0

Management of COVID-19 in Austere Operational Environments

(Prehospital & Prolonged Field Care), 23 Apr 2021



This practice management guide does not supersede DoD Policy. It is a guideline only and not a substitute for clinical judgment. It is based upon the best information available at the time of publication. It is designed to provide information and assist decision making. It should not be interpreted as prescribing an exclusive course of management. It was developed by experts in this field. Variations in practice will inevitably and appropriately occur when clinicians take into account the needs of individual patients, available resources, and limitations unique to an institution or type of practice. Every healthcare professional making use of this guideline is responsible for evaluating the appropriateness of applying it in the setting of any particular clinical situation.

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Intended Scope and Audience

This guideline is intended for the provider operating in an austere, limited resource setting. Providers have varying levels of knowledge, training, and experience in basic critical care concepts. It is not intended to be all inclusive, but to spur further thinking and identify areas where resource limitations or known diseases specify changes to usual practices. The management strategy described is designed for a 24-hour hold of a single critically ill patient and is tailored to the equipment and medications typically available in austere operational settings (Role 1 and Expeditionary Role 2). Refer to the most updated DoD COVID-19 Practice Management Guide for recommended clinical management, and CENTCOM COVID-19 Playbook for operational considerations.

Guiding Principles

1) Our primary mission remains the same. We must maintain the ability to provide damage control resuscitation and surgery in support of combat operations.
2) Prevention of disease transmission to medical personnel is a mission critical consideration for austere teams as there is generally very limited skill redundancy.
3) Primary capability limitations may include manpower, oxygen supply, ventilators, medications, and personal protective equipment (PPE).
4) Care of the critically ill COVID-19 patient is primarily supportive medical care plus appropriate disease transmission precautions.
5) Use of telemedicine to push critical care expertise as far forward as possible should be part of the operational plan.

Key Assumptions

1) Most providers operating in austere locations have equipment geared towards combat casualty care, not necessarily care for patients in severe respiratory failure.
2) Oxygen supply is generally limited to a few portable oxygen tanks and oxygen concentrators not designed to provide high volume oxygen support.
3) Laboratory and radiologic evaluation capabilities are generally limited to non-existent.
4) Local and international supply lines have been significantly affected by COVID-19, with reduced resupply or delivery of disease specific supplies (e.g., testing kits and viral filters).
5) Time to medical evacuation may be significantly prolonged given the global nature of this crisis, lockdown over sovereign airspaces, and the need to limit impact to military air assets.
6) Most austere locations consist of relatively small camps (usually less than 100-300 personnel) with primarily younger, healthier populations. However, some personnel may fall into high risk categories. As such, based upon current epidemiology, planning should account for 1-3 critically ill patients at each austere location.

Key Definitions

1) **Quarantine**: Separation and restriction of movement (ROM) for personnel potentially exposed to a contagious disease but without symptoms of illness. These personnel may have been exposed to a disease and do not know it, or they may have the disease but do not show symptoms. This is a command function that is medically supported.
2) **Isolation**: Separation of sick personnel with a confirmed contagious disease or high index of suspicion (i.e. person under investigation) from people who are not sick. This is a medical function requiring command support.
3) **Person Under Investigation (PUI):** A patient with signs and symptoms consistent with COVID-19 infection and possible exposure to the virus. In areas where COVID-19 is already widespread, symptoms alone may make the diagnosis of "PUI." All PUIs must be isolated.
4) **Contact Spread**: Spread of disease via direct contact with an infected patient or contaminated surface. Contact precautions aim to mitigate this method of transmission.
5) **Droplet Spread**: Spread of disease via relatively large liquid particles that settle from the air, typically within a few feet. Droplet precautions aim to mitigate this method of transmission.
6) **Airborne Spread**: Spread of disease via small liquid particles (aerosols) that remain aloft for prolonged periods of time and may travel longer distances. Airborne precautions aim to mitigate this method of transmission.

Key References

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Actions on Identification of a COVID-19 PUI

Personal Protective Equipment Considerations

1) The Centers for Disease Control and Prevention (CDC) recommends enhanced droplet precautions. Cover mucosal surfaces (eyes, nose, and mouth) and provide skin contact precautions.
2) N95 masks DO NOT work properly with facial hair; shaving is strongly recommended for anyone participating in direct patient care.
3) Personal Protective Equipment (PPE) should be donned/doffed per CDC instructions and following proper techniques to minimize the risk of self-inoculation.
4) If possible, have a trained observer watch donning and doffing to guard against accidental exposure of medical personnel.
5) The following procedures carry a significantly higher risk of virus aerosol formation:
    a. Tracheal Intubation
    b. Extubation (accidental or planned)
    c. Bag-Valve Mask Ventilation
    d. Any disconnection of the ventilator circuit
    e. Tracheal suctioning without in-line suction device
    f. Tracheostomy (and Cricothyroidotomy)
    g. Cardiopulmonary Resuscitation

Levels of PPE

Levels are based upon risk of disease and risk of procedure.
NOTE: the patient should wear a basic facemask (cloth or otherwise) whenever feasible to provide an additional barrier.

Minimum: Face covering, eye protection glasses, gloves, and makeshift gown.
NOTE: For patients with low probability of disease and where direct contact with the patient is low, gowns may not be required (mirroring conventional droplet precautions).

Better: Surgical mask or N95 mask, face shield (either standalone or with mask) and eye protection, gloves, gown (surgical or contact), head covering.

Best: N95 mask (with or without surgical mask covering) with face shield and disposable head covering or hooded face shield (e.g., Chemical, Biological, Radiological, Nuclear, and high yield Explosives (CBRNE) pro-mask) along with gown and gloves.

Conservation of PPE

1) COVID-19 can survive on various surfaces for up to 72 hours or longer.
2) Use cloth face covering when risk is low to conserve supply of surgical face masks and N95 masks needed for high risk procedures (e.g., endotracheal intubation).
3) Doff PPE in a manner that allows for it to be easily donned again without contacting contaminated surfaces (if possible).

4) For re-use of surgical face masks or N95 masks: while wearing gloves, store the mask in a paper bag in a dry, shaded/indoor area for 72 hours prior to using again. DO NOT use bleach or UV radiation (i.e. sunlight) to 'sterilize' the N95 – this will degrade mask effectiveness.
5) Eye protection glasses and face shields should be cleaned with a diluted bleach solution between uses.

Mask Recommendations

U.S. National Institute for Occupational Safety and Health recommends the following for extended use and re-use of N95 respirators:

1) N95 masks maintain their effectiveness for at least 8 hours of continuous or intermittent use.
2) N95 masks should be discarded following aerosol generating procedures (e.g., endotracheal intubation) or when visibly contaminated with bodily fluids.
3) Consider using a large face shield that sits in front of the mask, wear a surgical mask over-top of the N95, or masking the patient to minimize contamination.
4) Perform hand hygiene with soap and water or an alcohol-based hand sanitizer before and after touching or adjusting the mask.

Quarantine (Asymptomatic Personnel with Identified Exposure)

1) While separate berthing for quarantined individuals is optimal, living space is generally limited in austere settings. As such, berthing with individual rooms should provide adequate protection to allow quarantined individuals to remain in their room.
2) Individuals placed on quarantine per CDC screening guidelines are instructed to stay in their room and conduct self-observation for the development of any symptoms.
3) Teammates should check on the status of the quarantined individual several times daily and bring them food, water, and comfort items as needed.
4) Social distancing is strictly enforced when the individual needs to use the bathroom for toilet and hygiene. They should not use the gym, MWR, or any other common areas while under quarantine.
5) Depending on risk to force and mission requirements, mission critical personnel (including medical personnel) could be allowed to work (face covering, N-95 if possible, otherwise a cloth mask may be used). Early engagement of nonmedical leadership in such decision making is essential.

Isolation (Symptomatic Personnel)

1) ***PUI may not leave isolation*** berthing unless instructed to do so by medical personnel.
2) When outside of the isolation berthing, PUI will be required to wear a cloth face covering and clean hands with soap and water or alcohol based hand sanitizer.
3) No visitors allowed within the isolation berthing.

Initial Medical Evaluation

1) Pre-designate a provider as the COVID provider. This provider should perform all evaluations and procedures to limit exposure to other medical personnel, if possible. Remember, maintaining combat casualty care capability is still the priority. Balance the provider skillset and experience with potential impact on medical support for combat operations. The designated provider may not be the most experienced provider, but can consult with teammates as needed for management, procedures, and nursing care.
2) All patients presenting to sick call with any complaint should be screened for typical COVID-19 symptoms (fever, cough, dyspnea, gastrointestinal complaints) and risk of exposure.
3) If PUI presents to a provider other than the designated COVID attending provider, the patient should be provided a cloth face covering (or surgical mask) and escorted to pre-designated COVID treatment area.
4) If possible, all evaluations and treatment of PUI should be done outside the combat casualty care facility to mitigate potential for contamination of the facility.
5) Medical personnel performing the evaluation should wear the best available PPE (see Appendix B) balancing the supply of PPE with the threat of patient interaction.
6) Examination should include full vital signs including pulse oximetry, work of breathing assessment, pulmonary auscultation, skin temperature, and capillary refill.

Ancillary Tests

Minimum: Rapid Malaria Testing (if febrile in malaria endemic region)

Better (Above +):

- 12-Lead ECG
- Rapid Flu Testing
- Rapid Dengue Testing
- I-STAT arterial blood gas or venous blood gas
- Ultrasound (cardiac and pulmonary)

Best (Above +):

- PA and LAT Chest Films
- Respiratory Pathogen Film Array (i.e. Biofire)
- COVID-19 PCR Testing
- Other laboratory testing listed DoD COVID19 Practice Management Guide

Identifying Patients at Risk for Deterioration:

1) Among patients with mild to moderate symptoms and normal resting pulse oximetry, the risk of deterioration is increased in those presenting with dyspnea, desaturation on exercise testing, and epidemiologic risk factors for severe disease (age over 50, cardiovascular disease, pulmonary disease, immunosuppressive medications). These patients should be monitored closely and considered for early evacuation.

2) Exercise (Walk) Test: Have the patient jog or walk in place for 3 minutes. Inability to complete the test or desaturation below SpO_2 <94% confers a higher risk for clinical deterioration. This is a triage test used by several New York hospitals during the pandemic to help gauge the need for closer monitoring.

Consideration of Alternative Diagnoses

1) If a patient with symptoms possibly consistent with COVID-19 has known risk for or exposure to COVID-19, the patient should be managed as a PUI regardless of the differential diagnosis. This does not mean that alternative and/or comorbid diagnoses are impossible as COVID-19 patients can be co-infected with other pathogens.

2) Life threatening alternative diagnoses (e.g., pulmonary embolism, pneumothorax, acute myocardial infarction, etc.) should always be considered and managed according to standard practices for diagnosis and treatment.

Testing in Austere Locations

1) Most austere locations will be unable to test for COVID-19 using an approved polymerase chain reaction (PCR) assay. However, if testing does become available, the following should be considered:

   - The false negative rate for COVID-19 PCR assay is likely to be significant enough to merit a minimum period of isolation (or quarantine) regardless of test result.
   - Testing priority should be guided by the CDC priority for testing balanced against operational priorities. For example, a patient with mild symptoms and no risk factors for decompensation may not warrant immediate testing. However, if combatant command determines that the individual is mission critical, the testing may be considered a higher priority.

2) Given significant resource constraints in an austere environment (specifically the limited duration of oxygen supply, medication supply, and limited quantity of PPE) coordination for evacuation to the appropriate level of care should be initiated as soon as possible, even if the patient does not necessarily need urgent evacuation as it may take more than 24 hours to execute an evacuation mission. This underscores the importance for early evacuation coordination while simultaneously planning for prolonged care.

3) Appendix A describes a tiered Medical Condition (MedCon) flowchart developed for standardization of terminology across an area of responsibility (AOR) and between medical providers, medical planners, and operational leadership.

Isolation Billeting Location Considerations

1) Most austere locations have group billeting with shared ventilation, making the practice of 'self-isolation' impractical. While individual billeting with separated bathrooms is optimal, patient isolation cohorts may be the best option available with limited space.

2) Billeting should be able to expand to hold multiple patients of varying severity and allow adequate comfort for all patient categories (mild, moderate, and severe illness).

3) Billeting ventilation (i.e. environmental control units) should face away from any gathering areas and common walkways.

4) Billeting entrances should be well marked (e.g., "Isolation Area - No Unauthorized Access!") and include posted guides on proper PPE procedures.

5) Consider location relative to bathrooms and areas traversed to get to the bathrooms. If available, designate bathrooms for isolated patients only. If there is engineering support, a pit toilet can be constructed. Disposable water bottles can be used as urinals.

6) Consider designating a critical care area within or near the isolation area separate from the main medical facility/aid station. Additionally, consider the route that must be traversed in order to transport the patient to an evacuation platform. The focus should be, as much as possible, on preserving the ability to provide combat casualty care, if needed.

7) If confirmatory testing is available, considering cohorting isolated patients by positive test vs. untested or negative test to avoid needlessly infecting PUIs who do not in-fact have COVID-19.

Preparation of Isolation Billeting

1) ***Do not move PUI into isolation billeting before preparation is complete*****.**

2) ***All non-isolated personnel occupying the space must vacate the building*****.**

3) Allow PUI (while wearing a surgical mask) to gather personal belongings from lodging and move into isolation berthing.

   a. Personal hygiene items
   b. Bed sheets and clothing
   c. Electronic devices + chargers

4) If PUI is unable to retrieve items, personnel with mask + gloves (at minimum) should retrieve any essential items.

5) Basic medical items remain in isolation billeting at all times:

   a. Oral thermometer with box of sheaths
   b. Pulse oximeter(s)
   c. Alcohol based hand sanitizer
   d. Stethoscope(s)
   e. Manual blood pressure cuff(s)
   f. Box of surgical masks
   g. 14 day supply of Acetaminophen, ibuprofen and cold/flu medicine as available.

6) PPE Box (for providers, prepositioned outside isolation berthing):

   a. Min 3 gowns (either surgical or yellow contact precaution gowns)
   b. Min 3 N95 masks
   c. Min 6 surgical masks
   d. Min 3 face shields and/or cleaned eyepro
   e. Min 3 surgical caps or bouffant caps
   f. Box of gloves
   g. Tub of disinfectant wipes
   h. Spray bottle of dilute bleach

i. Paper towels (for cleaning)

j. Trash bags

7) Life Support Items

a. Hydration: Water bottles, juice containers, Gatorade, etc.

b. Food: MREs, meal supplement drinks, snacks, etc. Provide hot-meals as able.

c. Hygiene: Box of wet wipes. Encourage use of portable urinals (e.g., empty water bottles). If the bathroom must be shared with non-isolated personnel or if a designated bathroom traverses common areas, the PUI should be escorted by personnel wearing PPE while themselves wearing a mask. The escort will instruct anyone inside the bathroom to vacate prior to use. All surfaces used by the PUI must be cleaned with dilute bleach solution.

d. Trash: Small trash receptacle with bag inside isolation berthing. Large receptacle double bagged will be placed immediately outside the isolation berthing. Biohazard sign will be placed on top. Only medical personnel or designated non-essential/non-high risk personnel will dispose of this trash to minimize risk to others. PUI will be instructed to tie off small bags and place in a large container daily. Consider the local population access to trash and dispose following approved policy for biohazardous waste.

Continued Monitoring Considerations for Personnel in Outpatient Isolation

1) Maintain communication with personnel in isolation. The attending COVID provider will determine the need for more frequent assessments.

2) Once a patient meets MedCon2 criteria or higher, continuous monitoring is recommended as their risk of rapid decompensation rises significantly. (MedCon2: Progressive symptoms that are concerning based upon provider clinical judgment. See Appendix A.)

3) The Prolonged Field Care flowsheet provides a framework for recording frequent assessments and interventions. (See JTS Documentation in Prolonged Field Care CPG.)

4) Consider using video chat (e.g., WhatsApp) to obtain vital signs and perform visual assessment of patient to minimize exposure in MedCon1. (MedCon1: Mild flu-like symptoms, SpO2>94% on room air, hemodynamically normal. See Appendix A.) Patients can take their own pulse oximetry reading and temperature at pre-determined intervals or cohort patients in isolation billeting can do it for each other.

5) If concerning symptoms develop, the COVID attending provider performs an in-person exam using the best available PPE.

Command and Control Considerations

1) Notification of both medical and operational leadership is imperative and should occur soon after identification of a PUI.

2) Official notification in an approved format should be drafted and submitted to the command surgeon (or appropriate designee).

3) If MedCon2 or higher risk category, begin coordination for evacuation to a higher echelon of care as soon as possible.

4) Identify potential close contacts of PUI, screen for symptoms, and manage according to CDC guidelines for high risk exposure.

Performance Improvement Measures

Population of Interest

All hospitalized patients who are COVID-19 positive (includes confirmed and presumptive cases when testing is not available).

Intent (Expected Outcomes)

1) Initial presenting symptoms are documented in the population of interest.
2) Co-morbidities are documented in the population of interest.
3) COVID test sample collection and result times are documented in the population of interest.
4) When intubation is required, staff document levels of use (level 1-surgical mask, level 2-N95, level 3-Powered air-purifying respirator (PAPR)).
5) Recommended treatments for severe and critical COVID-19 patients are received early after hospital admission.

Performance/Adherence Metrics

1) Number and percentage of patients with initial presenting symptoms are documented in the history and physical (H&P) record.
2) Number and percentage of patients with a complete past medical history (PMH) are documented in the H&P.
3) Number and percentage of patients with smoking history are documented in the H&P.
4) Documented number and percentage of patients with COVID test sample collection and result times.
5) Number and percentage of patients requiring intubation procedures who have documentation of level of PPE used by staff (level 1-surgical mask, level 2-N95, level 3-PAPR).
6) Number and percentage of severe and critical patients receiving remdesivir in < 24 hrs and < 48 hrs.
7) Number and percentage of severe and critical patients receiving dexamethasone in < 24 hrs and < 48 hrs.
8) Number and percentage of severe and critical patients receiving COVID convalescent plasma (CCP) in < 24 hrs and < 48 hrs.

Data Source

- Patient Record
- DoDTR

System Reporting & Frequency

- The previous sections constitute the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.
- The JTS Chief, JTS Program Manager, and the JTS PI Branch will perform the system review and data analysis.

Responsibilities

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

Providing Medical Care to a COVID-19 PUI

Oxygen Supply Considerations

(See Appendix F)

1) Take inventory of the equipment and supplies available at your treatment facility. Important items include small oxygen concentrators (SAROS^{TM}), oxygen cylinders (D-cylinders and H-cylinders), and oxygen generating systems (POGS and EDOCS).
2) Identify the closest resource capable of filling oxygen cylinders. This may be a military biomedical maintenance team or host nation industrial gas supply company.
3) If you locate empty oxygen cylinders, begin the process of filling them right away. You will likely consume them quickly if you get a very seriously ill COVID-19 patient.
4) Develop a resupply plan for your oxygen cylinders. A very seriously ill COVID-19 patient will rapidly deplete oxygen supplies.
    - If your facility has the capability to fill oxygen cylinders, then develop a plan to refill tanks. Identify someone not directly involved in patient care since tank refill and patient care may need to occur simultaneously.
    - If your facility does not have the capability to refill oxygen cylinders, then develop a re-supply plan. One option is to coordinate medical cylinder exchange in conjunction with MEDEVAC missions.
5) The SAROS^{TM} oxygen concentrator can provide up to 3 Lpm of 100% O_2. However, when unplugged, battery will only last 30 minutes on continuous flow.
6) SAROSTM can be daisy-chained together to provide higher flow, approximating 5-6 Lpm. A suction Y-connector can be used to connect several together.
7) Ventilators waste less oxygen when using a high pressure hose. A full D-cylinder providing 15 Lpm of O_2 via disposable oxygen tubing will last 20-30 minutes. The same D-cylinder providing 100% FiO_2 through a ventilator connected via green high pressure hosing will last 30-45 minutes (depending on minute ventilation).
8) Reducing minute ventilation (e.g., sedation with or without paralysis) and oxygen consumption (reduce FiO_2 to absolute minimum to attain SpO_2 88-92%) will extend oxygen supplies.

9) If transporting patient(s) to an evacuation pick-up site, anticipate delay and bring double the estimated oxygen supply.

Ventilator Considerations

(See Appendix G, Appendix H and Appendix I)

1) Minimum requirement for an effective ventilator in severe hypoxic respiratory failure:
   a. Must be able to provide Positive End-Expiratory Pressure (PEEP).
   b. Must allow for titration of tidal volume and respiratory rate (control minute ventilation).
   c. Must be able to provide supplemental oxygen greater than room air (>21% FiO_2).
2) Commercial full function ventilators (e.g., Drager, Puritan-Bennett) may be available at some austere locations and are the ideal ventilators to use if available. These ventilators can perform advanced ventilation strategies and are indicated for treatment of COVID patients.
   ***Note**: They are not transport ventilators, as the instruments are sensitive and should remain in an area where they can be protected.* Transfer the patient to a transport vent for evacuation.
3) The Zoll (Impact) EMV+ 731 transport ventilator is available in many military equipment sets and certified to function in all aviation environments. IMPACT 754 ventilators are sufficient, but do not provide Pressure Control - Inverse Ratio Ventilation capability (discussed below).
4) Hamilton T1 transport ventilators provide specialized support options, including advanced pressure control options and integrated high flow oxygen therapy. Certified for ground transport and rotary-wing transport, but not approved for fixed wing aircraft (pressurized cabin) transport.
5) SAVe II rescue ventilators are an option with limited capability: PEEP only up to 10 cm H_2O and minute ventilation only up to 8 Lpm. Oxygen reservoir tubing for the air intake is required to provide supplemental oxygen. If this is the only device available at your location, arrange transfer to a location with more advanced ventilator as soon as possible.
6) SAVe I rescue ventilator has no adjustability and cannot provide PEEP. DO NOT manage critically ill COVID-19 patients with this device. Manual ventilation with a Bag-Valve-Mask (BVM), PEEP valve, and supplemental oxygen will be more effective.

Personnel Considerations

1) Minimize the number of personnel required to care for the PUI. Establish a priority list of who will be available to assist. Ensure that the rest of the team can maintain the combat casualty care capability.
2) In cases where evacuation may be delayed, establish work-rest cycles, allowing for adequate time to hydrate, eat, and sleep. This has been shown to reduce PPE waste, minimize provider exhaustion, and prevent accidental exposures.
3) Ambulatory PUIs ("walking wounded") can potentially assist in monitoring and providing care to more seriously ill patients.
4) Consider having someone (not directly involved in patient care) act as a runner.

Equipment/Supplies

The equipment and supplies needed for the management of a critical ill COVID-19 patient are summarized in Appendix L and Appendix M.

Clinical Care Considerations

Initial reports suggest that among COVID-19 patients who develop critical illness, the rapid decline typically starts about 5-7 days following the first symptoms. Closely monitoring these patients during this time period is critical for early intervention.

Airway Management

1) Minimize viral aerosol formation and direct exposure of medical personnel.
2) Use the best available PPE for high risk procedures like endotracheal intubation. (See Appendix B.)
3) Gauge the need for inserting an advanced airway on the patient work of breathing. COVID-19 patients decompensate rapidly – a low threshold for intubation allows more time for preparation and may prevent complications.
4) If the COVID attending provider does not feel comfortable with placing an advanced airway, consider teleconsultation and/or waiting for arrival of more experienced personnel (e.g., evacuation team). Never try to place an advanced airway unless you know how to do it.
5) One assistant is sufficient during intubation in most cases; however, an additional assistant can be standing by in the "warm" zone at least 2 meters away wearing appropriate PPE.
6) Passively pre-oxygenate with 100% O_2 for at least 5 minutes. Consider placing a surgical mask on the patient (over top of nasal cannula or non-rebreather mask).
7) Utilize strict rapid sequence intubation technique – avoid BVM ventilation if possible. If available, place viral filter in-line during use of BVM.
8) Utilize video laryngoscopy (i.e. GlideScope) if available for intubation to limit direct exposure. If unable to intubate or obtain adequate vocal cord visualization on the first pass, consider the placement of a laryngeal mask airway (LMA) with viral filter. Ventilate with the BVM and PEEP valve until oxygenation is adequate. Then, re-attempt the procedure.
9) Chest X-Ray may not be available or feasible to confirm tube placement. Utilize end-tidal carbon dioxide ($EtCO_2$) monitoring and auscultation to confirm placement.
10) General guide for tube size and depth is as follows: for males use 8.0 endotracheal tube (ETT) inserted to 25cm at the incisors; for females use 7.0 ETT inserted to 23cm at the incisors. In general, place as large an ETT as possible since secretions may be an issue.
11) If available, place heated humidification device (e.g., Hamilton H900) or heat and moisture exchanger (HME) in the INHALATION circuit of the ventilator tubing. If available, place a HEPA filter (microbiological filter) or HME-F (HME plus microbiological filter) in the EXAHALTION circuit of ventilator tubing.

Cricothyroidotomy

Cricothyroidotomy for definitive airway management:

1) Many medics and other providers operating independently in far-forward environments are trained to use cricothyroidotomy as their primary definitive airway. While the use of a surgical airway first line is appropriate in patients presenting in-extremis or with the loss of an airway (e.g., severely injured trauma patients with facial or neck trauma), patients with COVID-19 generally present with gradually progressive symptoms and intact native airways.
2) Early intra-theater transfer to a facility with advanced capabilities is preferable to early cricothyroidotomy whenever possible.
3) Laryngeal mask airway or other supraglottic airway placement may be a sufficient bridge to definitive airway placement. Placement of a mask over the LMA (hole cut in the middle of the mask for the LMA) will minimize aerosol spread from any air leak. PEEP above 10 cm H_2O via LMA may not be effective and may exacerbate any leak around the LMA. Sedation and analgesic requirements for an LMA may be slightly more than with a cricothyroidotomy.
4) Cricothyroidotomy without the ability to provide mechanical ventilation consumes significant resources (manpower required to bag-ventilate the patient with PEEP, inefficient delivery of oxygen via bag-ventilation, and significant aerosol risk to those providing care).

Medication Options

Systemic Corticosteroids

Professional societies recommend using systemic corticosteroids in the treatment of severe and critical COVID-19 (see the DoD COVID-19 PMG for more details). If unfamiliar with corticosteroid treatment regimens, discuss with advanced provider via telehealth prior to initiating therapy.

Antimicrobial Therapy

(to treat possible bacterial pneumonia co-infection)

1) Consider early use of azithromycin (500mg PO or IV daily for a minimum of 5 days) to treat mild to moderate community acquired pneumonia (CAP) in patients with lower respiratory tract symptoms and fever.
2) If azithromycin is not available, doxycycline (100mg PO or IV q12h) can be substituted for empiric treatment of bacterial pneumonia.
3) For patients with severe symptoms, recommend adding ceftriaxone (IV 2gm q24h is the best option) or ampicillin-sulbactam (3gm IV q6hr is a good alternative) or ertapenem (1g IV or IM q24h if it is the only available option).
4) Levofloxacin (750mg PO or IV q24h) is another reasonable option for empiric treatment of severe community-acquired pneumonia.

Fever Management

Fever management with acetaminophen every 6 hours (1000mg IV or 975mg PO or PR) as needed for temperature over 38°C.

Sedation and Analgesia

1) Sedation goal is Richmond Agitation and Sedation Scale (RASS) -1 to -2 (comfortable, transiently responsive to verbal stimulation) and synchronous with the ventilator. Increase sedation and/or

add narcotics to improve patient-ventilator synchrony. Use of paralytics may be required for very severe cases (as discussed below).

2) Ketamine may cause increased secretions which may require more frequent suctioning. If medication options are limited, consider more frequent dosing of midazolam to decrease the dose of ketamine required and potentially decrease the secretion burden.

3) A reference guide for starting and titrating a ketamine drip along with useful adjuncts is provided in JTS Analgesia and Sedation Management during Prolonged Field Care CPG.

4) Combined use of multiple sedatives (i.e. propofol, dexmedetomidine and/or midazolam) may act synergistically to decrease the total sedative dose and help to mitigate the hypotensive effects of propofol, however multiple continuous drips is not recommended outside of an ICU setting. A ketamine drip may be combined with bolus doses of additional medications.

5) *Caution should be used with combining propofol and dexmedetomidine*, especially in younger patients with higher vagal tone due to increased risk of bradycardia and hypotension.

6) Intermittent or doses of fentanyl or hydromorphone may be useful for analgesia and optimizing ventilator synchrony.

7) Low dose vasopressors may be necessary to support hemodynamics in the face of deeper sedation and higher PEEP. (See Appendix D.)

Bronchodilation

1) Use of metered-dose-inhalers (MDIs) over nebulized bronchodilators to treat wheezing will help to minimize risk for infectious aerosol.

2) If the ventilator tubing does not have a capped inlet for medication administration (aka MDI adapter) -- 1) clamp the ETT, 2) disconnect the ventilator, and 3) administer the MDI (6 puffs) directly into the INHALATION circuit. Then, reconnect the ventilator and unclamp ETT to insufflate the medication.

3) Magnesium Sulfate 2gm IV over 20 minutes (similar to treatment of an asthma exacerbation) may be a safer alternative for treatment of bronchospasm given the risks of disconnecting the circuit.

Respiratory Care

Lung-protective ventilation

1) Initiate lung-protective ventilation strategy.
   a. Tidal volume 6mL/kg ideal body weight (IBW)
      - IBW – Men = 50 kg + (2.3 kg x (height in inches - 60))
      - IBW – Women = 45.5 kg + (2.3 kg x (height in inches - 60))
   b. Maintain peak pressure less than 35 mm Hg
   c. Maintain SpO_2 88-95% or PaO_2 55-80 mm Hg
   d. Permit Hypercarbia (but keep arterial pH > 7.30)
   e. Use ARDSnet protocol. (See Appendix E)

2) If ETT must be disconnected from the ventilator for ANY reason, clamp the ETT to prevent decruitment and minimize viral aerosol formation.

3) If in-line suction devices are not available, de-recruitment will likely occur with suctioning. Salvage recruitment maneuvers may be necessary.

4) On the EMV+ 731 (mode AC-V) a recruitment maneuver can be done as follows:

   a. Change upper limit of Peak Inspiratory Pressure (PIP) alarm to 50 cm H_20.
   b. Decrease tidal volume as low as possible (50mL).
   c. Increase PEEP to 30-40 cm H_20.
   d. Hold for 40 seconds (if signs of hemodynamic instability develop, stop the recruitment maneuver, and resume prior settings).
   e. Increase PEEP to 2 cm H_20 ABOVE prior PEEP setting.
   f. Increase tidal volume back to prior setting.
   g. Return upper limit of PIP alarm to prior setting.
   h. Monitor for any persistence of hemodynamic instability or persistently high PIP (Although rare, the high PIP encountered during RMs can cause pneumothorax).

5) Dry Lung. The mantra "a dry lung is a happy lung" still applies in severe COVID-19 care; over resuscitation is likely to be harmful. Fluid resuscitation should be guided by assessment of volume responsiveness. If available and evacuation is significantly delayed, loop diuretics can be used to attain a net even volume status, providing the patient is hemodynamically stable (i.e. not requiring vasopressor support).

Management of Oxygenation

1) Escalate PEEP to 12 cm H_20 as aggressively as possible as hemodynamics allow to optimize oxygenation, minimize FiO_2 needs, and extend oxygen supply.

2) Use the ARDSNet Protocol LOW PEEP table as a guide for further titration of PEEP. Refer to JTS Acute Respiratory Failure CPG.

3) Be prepared to start vasopressors and judicious use of IVF to support pre-load in the face of high PEEP (aka PEEP tamponade).

4) Consider a combination of paralysis and prone positioning early to lengthen duration of available oxygen supply.

5) Consider Inverse Ratio Ventilation (IRV) once patient reaches PEEP 18 cm H_20 on the LOW PEEP table.

Management of Ventilation

1) If blood gas analysis is not available, a general $EtCO_2$ goal of 35 mm Hg +/- 5, is adequate. However, if blood gas analysis is available (i.e. i-STAT), recommend obtaining a baseline PCO_2 and correlate with $EtCO_2$, especially since the gradient between the two is much wider in patients with significant lung disease (i.e. an $EtCO_2$ of 40 may actually represent a PCO_2 of 60 with a pH around 7.24).

2) The manual breath button on the bottom left of EMV+ 731 allows for manual measurement of plateau pressure (Pplat). The Pplat goal is less than 30 cm H_2O with a secondary goal of maintaining

driving pressure (Pplat minus PEEP) below 15 cm H_2O. In the absence of Pplat, a PIP target of less than 35 cm H_20 is also reasonable.

3) If Pplat is greater than 30 cm H_20, decrease set tidal volume by 1 mL/kg steps (about 50-80 mL). Titrate set respiratory rate (RR) up increments of 2 bpm to maintain pH and $EtCO_2$ at goal. Avoid RR above 35 bpm given significant risk for breath stacking and auto PEEP (which will eventually make the patient hemodynamically unstable).

4) If i-STAT with blood gas cartridges are available, consider serial blood gas evaluation (adjusting frequency depending on patient stability).

Reverse Trendelenburg

Reverse Trendelenburg positioning (head of bed up, spine straight) can help offload abdominal pressure contributing to increased thoracic pressure. This can be extremely helpful maneuver to improve pulmonary compliance in obese patients and/or those with intra-abdominal hypertension.

Secretion Management Considerations

1) Increased secretions and mucous plugging of the bronchial tree are extremely common causes for increased oxygen requirement and difficulty with ventilation in patients with severe respiratory failure from lung infections.

2) Anecdotal evidence regarding COVID-19 patients suggests that secretions are problematic in some patients. Additionally, in-line suction (closed system) devices that minimize aerosol formation and de-recruitment are not usually available in austere settings.

3) Heated humidification prevents desiccation (drying out) of secretions and promotes ciliary clearance.

   - Heated-humidification devices are designed to be used along with ventilators (e.g., Hamilton H900).
   - Heat-Moisture Exchangers (HME) are supplies that fit in-line with the ventilator tubing and trap heat and moisture within the circuit.
   - HME Filters (HME-F) are supplies that fit in-line with the ventilator tubing and provide HME and microbiologic filtration.

4) Pharmacologic treatment for secretions generally falls into one of three categories: mucolytics (break up mucous), bronchodilators, or anti-sialagogues (anti-salivation).

   - Mucolytics:
     - Pre-treat with for 10-15 minutes.
     - 20% N-acetylcystine (Mucomyst) as 1-2mL direct instillation into ETT every 6 hours as needed for secretion control.
     - 3% Saline (Hypertonic Saline) as 5mL direct instillation into the ETT every 6 hours as needed for secretion control.
   - Bronchodilators: Albuterol will help dry up secretions. While ultimately decreasing secretion volume, bronchodilators may also increase the risk of a mucous plug formation. Use with caution.
   - Anti-Sialagogues: Has the greatest effect on oral secretions with modest effect on pulmonary secretions (and therefore not routinely recommended for COVID-19 patients). However,

antisialagogues such as scopolamine and glycopyrrolate are often effective at attenuating the increased secretions caused by high dose ketamine.

5) Percussive chest physiotherapy is often provided by respiratory therapists in Role 3 facilities to facilitate secretion clearance. Manual (with hands) or mechanical (with percussive physical therapy devices) can be used to create the same effect.

Adjunctive Strategies for Severe ARDS

1) There is no single right answer as to which strategies should be used in severe ARDS. Each approach may or may not be feasible due to the resource constraints of the austere environment. If unfamiliar with these techniques, obtain teleconsultation.

2) Pressure Control – may include Inverse Ratio Ventilation (PC-IRV):

   a. EMV+ 731 with the most recent software package has the capability to do PC-IRV. While using AC-P mode, PC-IRV is achieved by increasing the Inspiratory-to-Expiratory (I:E) ratio above 1:2 (i.e. 1:1, 2:1, 3:1 and higher).

   b. PC-IRV cannot fully approximate Airway Pressure Release Ventilation (APRV), but is still the best available salvage mode using EMV+ 731.

   c. Once PEEP is maximized (or limited by peak inspiratory pressure) and oxygenation is still not yet at goal, increase the I:E ratio incrementally.

   d. Tidal volume goal remains the same as with conventional ventilation; adjust cycle time (60/RR) to optimize minute ventilation.

   e. Higher I:E ratios are not physiologic, so PC-IRV will likely require increased depth of sedation for patient comfort and synchrony.

3) Paralysis for Patient-Ventilator Synchronization

   a. Adequate depth of sedation is essential prior to starting a paralyzing medication; recommend RASS greater than -2.

   b. SCCM and DoD COVID-19 Practice Management Guide recommend intermittent paralytics over continuous infusions, if possible. Continuous infusion can result in prolonged paralysis if not closely monitored, especially if muscle twitch monitor is not available.

   c. Paralysis with Vecuronium:

      - Bolus: 5mg to 10mg every 60-90 minutes as needed.
      - Infusion: 0.8 to 1.2mcg/kg/min (approx. 80mcg/min for 80kg).
      - Without pump: 40mg vecuronium in 250mL bag (50mL wasted) of normal saline yields 40mg/250mL = 160mcg/mL. For 80mcg/min = 0.5mL/min ~ 1gt every 12 seconds in 10gt tubing.

   d. Monitoring Goal:

      - Absence of muscle movement and no evidence of spontaneous breathing on the ventilator. If possible, titrate to 2/4 TOF (testing device likely only available for surgical teams).
      - Increased HR and BP may suggest inadequate sedation and should be empirically treated by increasing sedation.

- Once the patient is stabilized, consider holding the paralytic at least once every 24 hours to provide for assessment of sedation depth.
- DO NOT hold sedation until paralytic wears off unless absolutely necessary (e.g., sudden hypotension).

4) Prone Positioning
   a. "Awake Self-Proning" with high flow nasal cannula devices has been successfully used in patients with moderate to severe COVID-19 lung disease. If patients are unable to tolerate prone positioning (i.e. strong desire to remain in a tripod position), DO NOT force them into the prone position.
   b. Reference DoD COVID-19 Practice Management Guide for full details on prone positioning precautions and procedures.
   c. Placement of either a central line or additional peripheral access is strongly encouraged PRIOR to prone positioning.
   d. Have push-dose vasopressor medication available during the process of prone positioning and un-positioning, as hypotension frequently occurs.
   e. Proning cycle is generally 16 hours of prone positioning each 24 hours. Match the proning cycle to the daily care plan as much as possible.
   f. Prone positioning may not be feasible or safe during evacuation.

Anticipate Complications

1) Pneumothorax can occur with higher PIP. Sudden increases in PIP and/or hemodynamic instability may indicate pneumothorax.
2) Pneumomediastinum with subcutaneous emphysema can also develop with the use of high PEEP (typically from dissection of air into the adventitia of small bronchi/bronchioles). The development of crepitus across the chest, neck, and/or upper extremities suggests the presence of this condition. Tension physiology from pneumomediastinum is EXCEEDINGLY rare and usually no intervention is needed.
3) Acute kidney injury leading to renal failure is a genuine threat to seriously ill COVID-19 patients. Patients unable to make urine can develop fatal arrhythmias from electrolyte abnormalities and acidotic blood. They need to be evacuated to a location capable of renal replacement therapy as soon as possible.
   a. Oliguria is defined as less than 0.5 mL/kg/hour of urine output (UOP).
   b. Oliguric patients should receive a bolus of 500 cc crystalloid. This may be repeated once if UOP does not improve. If the patient remains oliguric after a 1L bolus, consider the onset of acute tubular necrosis (ATN), especially if UOP remains low for more than 6 hours.
   c. As formal creatinine testing for acute kidney injury (AKI) is not likely to be available, consider urine dipstick testing with attention to specific gravity, proteinuria, and hematuria:
      - An abnormally low (dilute) specific gravity in the setting of oliguria suggests tubular damage and the inability to concentrate urine.
      - Significant proteinuria can be seen in ATN; however, this is not specific and can be seen in a variety of acute medical conditions.

- Hematuria may suggest the presence of myoglobinuria – consider rhabdomyolysis as a cause of acute kidney injury.

d. If UOP suddenly declines or stops, flushing the Foley and/or performing a bladder ultrasound scan can help determine if the problem is mechanical (Foley blockage) or organic (true kidney injury).

e. Once ATN sets in, ***do not aggressively fluid resuscitate or diurese*** simply to meet UOP goals. Use alternative markers of fluid responsiveness (like blood pressure response to passive straight leg raise) to help determine the need for further fluids and vasopressor medications.

f. Monitor closely for the development of electrolyte disturbances, specifically metabolic acidosis and hyperkalemia. Use medical management of hyperkalemia as appropriate. The JTS CPG on Hyperkalemia and Dialysis in the Deployed Setting describes field-expedient techniques for peritoneal dialysis; however, this should be done in concert with teleconsultation.

Hemodynamics & Monitoring

1) An IV pump is recommended over dial-a-flow and drip-chamber titration (if available).
2) When outdoors, place the monitor, ventilator, and IV pumps upwind and as far away as possible from the patient to minimize contamination of caregivers.
3) Establish arterial line monitoring early when possible for patients with severe COVID-19 disease as they often become hemodynamically unstable.
4) If possible, establish central access early in anticipation of the need for continuous vasopressors. Multiple peripheral IVs may also be needed for infusions of sedatives, analgesia, antibiotics, etc.
5) A conventional central venous catheter can be placed through an introducer catheter (i.e. Cordis) to expand the number of available infusion ports. This should be done during the initial insertion under sterile technique, if possible.
6) Some severely ill COVID-19 patients may develop dilated cardio-myopathy with florid cardiogenic shock. This may be secondary to systemic inflammation, stress, or a direct viral myocarditis. Patients may also develop arrhythmias. Manage arrhythmias following Red Cross advanced life support guidelines.
7) An unexpected change in the vital sign trends or hypotension out of proportion to sedation and PEEP should merit evaluation for additional causes of shock. Limited transthoracic echocardiography may be useful in discriminating between hypovolemic, cardiogenic, and distributive shock (in personnel trained to perform the assessment).
8) Utilize dynamic parameters (i.e. skin temperature, capillary refilling time, pulse pressure variation, blood pressure response to passive straight leg raise, and/or serum lactate measurement) over static parameters to help guide the need for further fluid resuscitation (Surviving Sepsis Campaign COVID-19 Guidelines).
9) Norepinephrine is the first line vasopressor for most causes of shock. Fixed rate vasopressin infusion (0.04 units/min) is useful as an early adjunct in non-cardiogenic shock; start vasopressin when norepinephrine reaches doses above 12mcg/min. Epinephrine is sometimes the only option available in remote locations.
10) Vasopressors should be titrated to a MAP goal of 60- 65 mm Hg. (Surviving Sepsis Campaign COVID-19 Guidelines.)

Continued Care & Prophylaxis

1) Nasogastric or orogastric tube (NG/OGT) should be placed early for gastrointestinal decompression. If medical evacuation is significantly delayed (greater than 24-48 hours), consider starting enteral nutrition.
2) Enteral nutrition is contraindicated in hemodynamically unstable patients (i.e. those on high or increasing doses of vasopressors). Low volume tube feeding on patients with stable low doses of vasopressors is generally safe.
3) At a minimum, confirm position of gastric tube placement with auscultation over both lung fields and the abdomen along with aspiration of gastric contents. Urinalysis test strips for pH may provide an addition method for NG/OGT placement confirmation in patients not on acid suppressive therapy.
4) Goal 25-30 kcal/kg/day + 1-1.2 gm/kg protein; however, this might be difficult, especially in the absence of formal concentrated tube feeds.
5) Meal supplement drinks are not sufficient. For example, one Muscle Milk Light bottle contains only 150 kcal and 28 gm protein in 500 mL, which is extremely dilute compared to most tube feeding formulations. This potentially increase extra-vascular lung water (especially in the setting of critical illness) with minimal benefit to nutritional status.
6) A more concentrated alternative is to use commercially available protein powder (with similar caloric/protein content per scoop) at 1/4 the recommended concentration and mix in a blender until no clumps are visible. Administer in small volume boluses (e.g., 60mL via Toomey syringe) as tolerated every 2 to 4 hours to a goal of 1 gm/kg/day protein content.
7) Further recommendations for enteral nutrition can be found in JTS CPG for Nutritional Support Using Enteral and Parenteral Methods.
8) If possible, blood sugar checks should be obtained at least every 6 hours, particularly for those with known diabetes mellitus.
9) Venous Thromboembolism (VTE) prophylaxis should be given as long as there are no contraindications. Patients with COVID have demonstrated and increase risk of the formation of thrombus formation, therefore it is recommended to administer Lovenox 30 mg SQ twice daily (avoid if evidence of renal failure) or 7,500 units heparin SQ every 8 hours.
10) If pharmacologic prophylaxis is not available, manual ankle plantar/dorsi-flexion range of motion exercises and lower extremity massage every two hours. Consider applying compression stockings if available. DO NOT use ACE wraps.
11) Stress-Ulcer Prophylaxis should be given to all intubated patients as long as there are no contraindications. Famotidine 20 mg IV every 12 hours or 20 mg via NG/OGT twice daily, or consider and a proton pump inhibitor, if available (i.e. pantoprazole 40 mg IV daily or omeprazole via NG/OGT daily).
12) Ventilator Associated Pneumonia prevention bundle applied to the limitations of an austere environment includes:
    - Head-of-bed elevation to 30 degrees
    - Suction the oropharynx as needed
    - Brush teeth every 12 hours, ideally with commercially prepared Chlorhexidine oral care if available.

13) The JTS CPG for Nursing Interventions in Prolonged Field Care provides in-depth discussion of the nursing tasks that may be required if medical evacuation is significantly delayed.

Cardiopulmonary Resuscitation

Cardiopulmonary arrest is a difficult topic. Generally speaking, in cases of cardiac arrest, Cardiopulmonary Resuscitation (CPR) in an austere environment may not be a wise use of resources unless the etiology for the arrest is rapidly reversible. Additionally, significant aerosol generation will invariably occur during CPR of a COVID-19 patient. It is reasonable during a pandemic to establish medical rules of engagement that discourage providers from performing CPR on infected patients. If CPR is performed, efforts should focus on reducing provider exposure to COVID-19 and prioritizing strategies with lower aerosol formation risk. (See DoD Covid-19 PMG.)

Patient Evacuation Considerations for Austere Medicine

Each AOR should develop its own plan for categorizing COVID-19 patients (for the purposes of isolation and evacuation) based on guidance found in DoD policy.

Medical Evacuation

Medical Evacuation using MedCon levels described in Appendix A is one example.

1) Patient movement should be anticipated for COVID-19 PUIs categorized as MedCon 2 or higher. There is no reason to delay notification request for evacuation.
2) Ground and Air Medical Transport will depend on local CASEVAC/MEDEVAC notification plan and CASEVAC/MEDEVAC platforms available for transport.
3) When clinically and operationally feasible and within the provider's scope of practice, obtain central venous access in anticipation of need for multiple infusions, including vasopressors, during transport. Obtain at least two peripheral IV's or one peripheral plus one central line access prior to transport, if possible.
4) Early placement of arterial line for invasive pressure monitoring is recommended, if available.
5) If there is evidence or suspicion for acute coronary syndrome or myocarditis, coordinate the medical management via teleconsultation prior to transport, if possible.
6) Patients requiring >3 Lpm oxygen support to maintain oxygen saturations >93% may not tolerate the hypoxic environment of aeromedical evacuation even with cabin altitude restrictions:
    a. Given concerns surrounding risk associated with procedures done emergently during transport, consider the need endotracheal intubation prior to transport.
    b. The most experienced provider should perform the procedure to secure the airway. Use a video laryngoscope (if available) and rapid sequence induction.
    c. Minimize people in the room during the procedure. Verify all staff have the best available PPE. (See Appendix B.)
    d. Consider consulting the Advanced Critical Care Evacuation Team (ACCET) DSN 312-429-BURN (2876) before transporting patients on moderate to high ventilator settings (PEEP > 14 and FiO_2 > 70%). Refer to JTS CPG for Acute Respiratory Failure.

e. If prone ventilation is to be utilized in-flight, it should be initiated on the ground with adequate time to document patient stability before transport.

7) If intubated, an NG/OGT should be placed pre-flight and attached to intermittent suction.

8) Pre-drawn and pre-mixed medications with primed tubing are examples of time saving measures to be optimized on the patient prior to transport.

9) Prepare patient records for handoff including medical notes, ECGs, laboratory results, and imaging results (if available).

10) Prepare patient belongings and ID/passport to accompany the patient.

11) Place PPE for flight on patient including eye protection and ear protection, and DO NOT forget face covering if not intubated.

Transition of Care for Evacuation

1) Early patient reporting allows the evacuation team to prepare.
   a. The sending facility medical team should provide contact information (if possible).
   b. The evacuation team should contact the sending facility prior to mission (if possible).
2) Handoff to the transport team should include:
   a. Up-to-date COVID-19 testing status (PUI vs confirmed).
   b. Current vital signs, exam findings, and recent trends or changes.
   c. Current medication regimen if initiated (including antibiotics and anticoagulants).
   d. Critical care medication regimen (sedation, analgesia, paralysis, and vasopressors).
   e. Current PPE status, oxygen requirements and ventilator settings.
   f. Any potential COVID-19 related complications identified during management (e.g., heavy respiratory secretions).
3) Upon evacuation team arrival to receive the patient, handoff report should be repeated with key elements above, including any recent patient changes.
4) Transition to the evacuation team monitoring and support equipment will present risk of exposure to healthcare team. In an attempt to mitigate this risk, consider the following:
   a. Personnel should be limited to those directly involved in the care of the patient.
   b. Best available PPE should be worn by everyone involved in the care transition.
   c. ETT clamping technique should be instituted to limit aerosol creation during all ventilator circuit breaks including transfer to evacuation team ventilator.
   d. Sufficient time should be allotted to confirm adequate oxygenation and ventilation prior to departure of the evacuation team.

Establishing a Plan for Telemedicine Consultation

1) Regional Medical Operations Cell should prospectively publish local and regional PACE (Primary-Alternate-Contingency-Emergency) plans for both operational and clinical consultation. Forward-stationed medical teams should test these options PRIOR to needing urgent consultation.

2) Make use of telehealth resources such as the ADVISOR line (866-972-9966, or 833-238-7756), that includes the Virtual Critical Care Consultation (VC3) service. The ADVISOR program is specifically designed for operational virtual health support. Additionally, many VC3 consultants have deployed to remote locations and can help work through the unique problems faced in austere settings. Additional information on ADVISOR can be obtained by emailing dod.advisor_office@mail.mil.

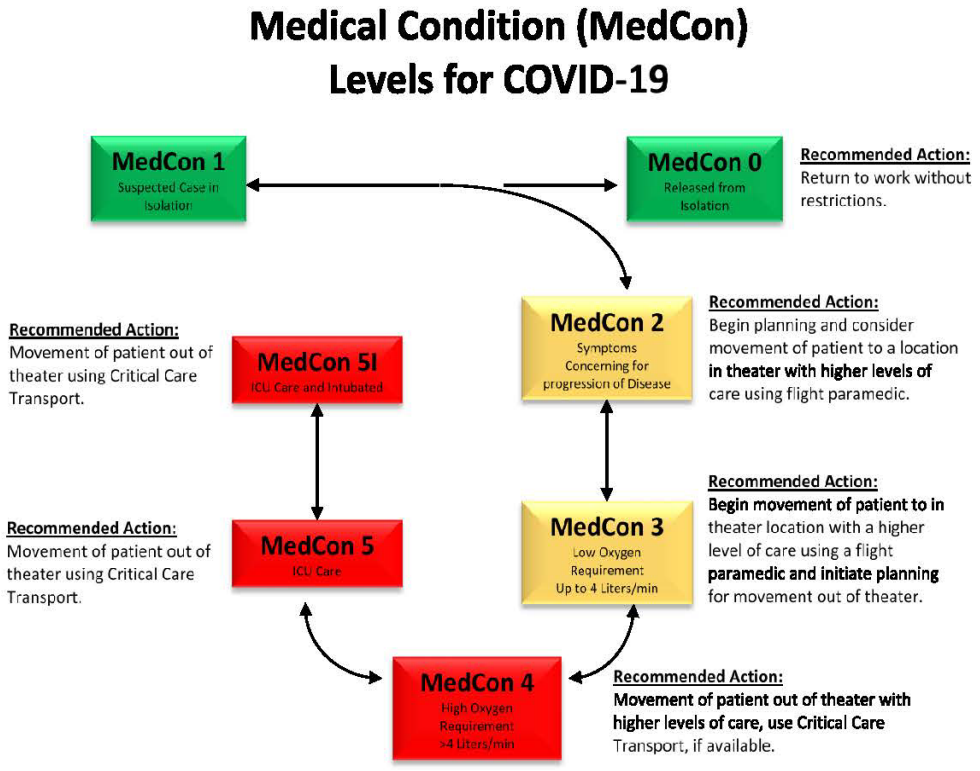
3) Alternatively, contact the following MEDCENs and ask for the on-call critical care staff:

Landstuhl Regional Medical Center, Germany. DSN: 314-590-7141 Intensive Care Unit
Walter Reed National Military Medical Center, MD. (301) 295-4611, option 4 Command Duty or (301) 295-4810 Emergency Room
Madigan Army Medical Center, WA. (253) 968-1110 Information Desk
Brooke Army Medical Center, TX. (210) 916-0808 Emergency Room
Naval Medical Center Portsmouth, VA. (757) 592-5473 Critical Care, (757) 953-1365 Emergency Room
Eisenhower Army Medical Center, GA. (706) 787-6938/6019 AOD or (706) 787-6039 Emergency Room
Travis Air Force Base Medical Center, CA. (707) 423-3040 ICU or (707) 423-3825 Emergency Room
Tripler Army Medical Center, HI. (808) 433-6661 Information Desk or (808) 433-4032 ICU or (808) 433-3707 Emergency Room
William Beaumont Army Medical Center, TX. (915)892-6880 House Supervisor or (915) 742-2139 ICU
Keesler Air Force Base Medical Center, MS. (228) 376-0500 Emergency Room

4) Always be conscious of the need to maintain patient privacy and operational security.

5) Using a standard telemedicine script will improve communications and recommendations for patient management. (See Appendix K.)

Appendix A: Medical Condition Levels


Medical Condition (MedCon) Levels for COVID-19
MedCon 1
Suspected Case in Isolation
MedCon 0
Released from Isolation
Recommended Action:
Return to work without restrictions.
MedCon 2
Symptoms Concerning for progression of Disease
Recommended Action:
Begin planning and consider movement of patient to a location in theater with higher levels of care using flight paramedic.
Recommended Action:
Movement of patient out of theater using Critical Care Transport.
MedCon 5I
ICU Care and Intubated
Recommended Action:
Movement of patient out of theater using Critical Care Transport.
MedCon 5
ICU Care
MedCon 3
Low Oxygen Requirement Up to 4 Liters/min
Recommended Action:
Begin movement of patient to in theater location with a higher level of care using a flight paramedic and initiate planning for movement out of theater.
MedCon 4
High Oxygen Requirement >4 Liters/min
Recommended Action:
Movement of patient out of theater with higher levels of care, use Critical Care Transport, if available.

Intent and Implications on Evacuation:

MedCon 1: Mild flu-like symptoms, SpO2 >94% on room air, hemodynamically normal. Overall, there is low likelihood of these patients significantly worsening in the next 24-48hrs. These patients may not need evacuation to higher level of care.

MedCon 2: Progressive symptoms that are concerning based upon provider clinical judgement. This is an "early warning" phase to prepare to evacuate.

MedCon 3: Requiring supplemental O2 to maintain SpO2 >92% at flow rates *not* significantly exceeding oxygen condenser capabilities (i.e. SAROS). While these patents may not necessarily exceed local capabilities, they represent a population at risk of rapid decompensation in the next 24-48hrs.

MedCon 4: Requiring supplemental O2 to maintain SpO2 >92% at flow rates *beyond* condenser capabilities (i.e. need to use D-cylinder oxygen support). These patients exceed the local capabilities for prolonged care of a patient in respiratory failure and/or will deplete oxygen supplies in less than 24 hours. These patients represent a high risk for hemodynamic deterioration and/or emerging requirement for mechanical ventilation.

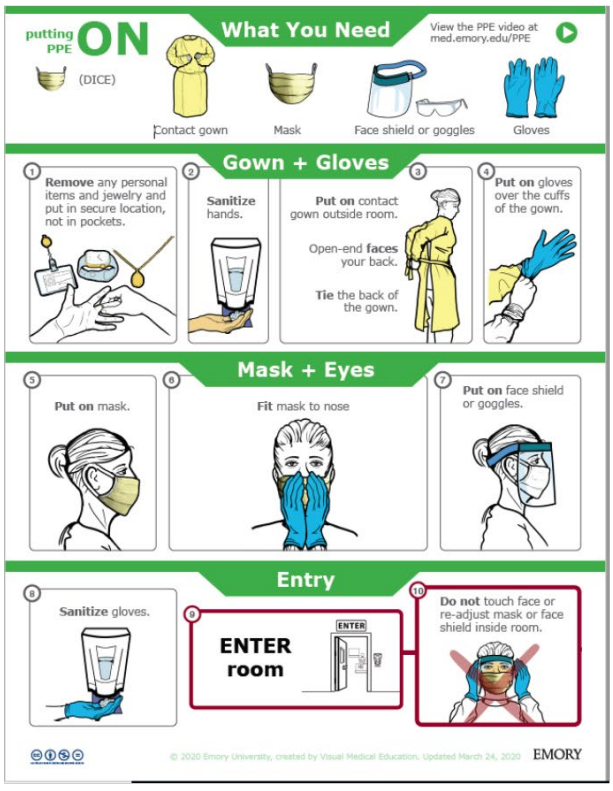
MedCon 5: Patients requiring advanced airway management up to and including definitive airway placement and/or with continued hemodynamic instability. These patients need urgent medical evacuation with critical care support to Role 3 or higher facilities.

Appendix B: Personal Protective Equipment (Courtesy Emory University CY20)

Good	Better	Best	Best of the Best
STANDARD + DROPLET PRECAUTIONS *Don and doff procedures occur in warm areas • **Gloves-single pair** • **Scarf or Balaclava** • **Eye Pro or Goggles** • **Disposable T-Shirt**	**DROPLET + AIRBORNE PRECAUTIONS** *Don and doff procedures occur in warm areas • **Double Gloves** • **Surgical Mask** • **Eye Pro or Goggles** • **Disposable Gown**	**DROPLET + AIRBORNE PRECAUTIONS** *Don and doff procedures occur in warm areas • **Double Gloves** • **N-95 Mask** • **Full Face Shield** • **Disposable Gown** • **Hood or Head Cover**	**DROPLET + AIRBORNE PRECAUTIONS** ** HIGH RISK EXPOSURE TO AEROSOLIZED DROPLETS ** • **Double Gloves** • **Surgical Mask covering** • **N-95 Mask** • **Full Face Shield** • **Tyvek® Suit - Hooded** • **Disposable Foot Covering**

Intubation

LOW — RELATIVE RISK / INTENSITY OF EXPOSURE → HIGH


putting PPE ON
(DICE)
What You Need
View the PPE video at med.emory.edu/PPE
Contact gown
Mask
Face shield or goggles
Gloves
Gown + Gloves
1 Remove any personal items and jewelry and put in secure location, not in pockets.
2 Sanitize hands.
3 Put on contact gown outside room.
Open-end faces your back.
Tie the back of the gown.
4 Put on gloves over the cuffs of the gown.
Mask + Eyes
5 Put on mask.
6 Fit mask to nose
7 Put on face shield or goggles.
Entry
8 Sanitize gloves.
9 ENTER room
10 Do not touch face or re-adjust mask or face shield inside room.
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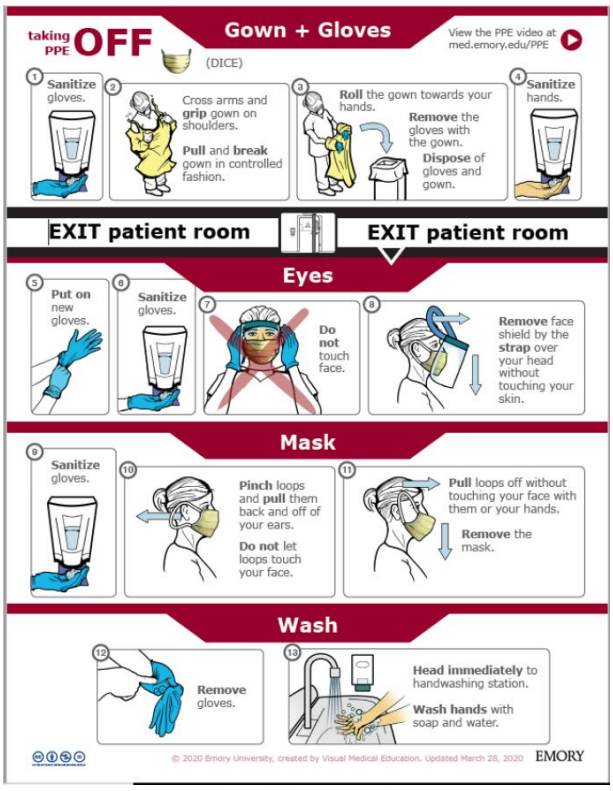
EMORY


taking PPE OFF
(DICE)
Gown + Gloves
View the PPE video at med.emory.edu/PPE
1 Sanitize gloves.
2 Cross arms and grip gown on shoulders.
Pull and break gown in controlled fashion.
3 Roll the gown towards your hands.
Remove the gloves with the gown.
Dispose of gloves and gown.
4 Sanitize hands.
EXIT patient room
EXIT patient room
Eyes
5 Put on new gloves.
6 Sanitize gloves.
7 Do not touch face.
8 Remove face shield by the strap over your head without touching your skin.
Mask
9 Sanitize gloves.
10 Pinch loops and pull them back and off of your ears.
Do not let loops touch your face.
11 Pull loops off without touching your face with them or your hands.
Remove the mask.
Wash
12 Remove gloves.
13 Head immediately to handwashing station.
Wash hands with soap and water.
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Appendix B: Continued…

Mask Guidance

SURGICAL MASKS

DISCARD MASK IF:

- Contaminated with blood, respiratory or nasal secretions, or other bodily fluids from patients.
- Obviously damaged or hard to breathe through.
- At the conclusion of your shift.

EXTENDED USE:

- Wear mask for ENTIRE shift unless soiled, damaged, or hard to breathe through.
- Do not touch the mask. If you touch or adjust your mask, you must immediately perform proper hand hygiene.
- Leave the patient care area if you need to remove your mask.
- Consider use of a face shield over mask.

REUSE:

- Masks that fasten via ties that are unable to be undone and are torn need to be discarded.
- Masks should be carefully folded so the outer surface is held inward and against itself to reduce contact with the outer surface during storage.
- Keep used masks in a clean, breathable container such as a paper bag between uses. Do not store in a plastic bag. Keep in a clean space outside patient room, such as a wall locker next to patient room or top of the isolation cart. To prevent accidental use of another's mask, label the container:
  - First initial and last name of owner
  - Strap of mask with first initial and last name of owner

Glossary

Extended Use — The practice of wearing the same mask/respirator for repeated close contact encounters with several patients, without removing the mask/respirator between patient encounters.

Reuse — The practice of using the same mask/respirator for multiple encounters with several patients but removing it after each encounter.

N95 RESPIRATORS

Extended and limited reuse of respirators were recommended for conserving respirators during previous respiratory pathogen outbreaks and pandemics.

Use face shield over N95 respirator to reduce surface contamination.

Perform hand hygiene with soap and water or an alcohol-based hand sanitizer before and after touching or adjusting respirator.

DISCARD N95 RESPIRATOR IF:

- Used for aerosol-generating procedure.
- Contaminated with blood, respiratory or nasal secretions, or other bodily fluids from patients.
- Obviously damaged or hard to breathe through.
- Reused (donned/doffed) a maximum of five times.

EXTENDED USE:

Extended use may be implemented when multiple patients are infected with the same respiratory pathogen and patients are placed together in dedicated waiting rooms or hospital wards.

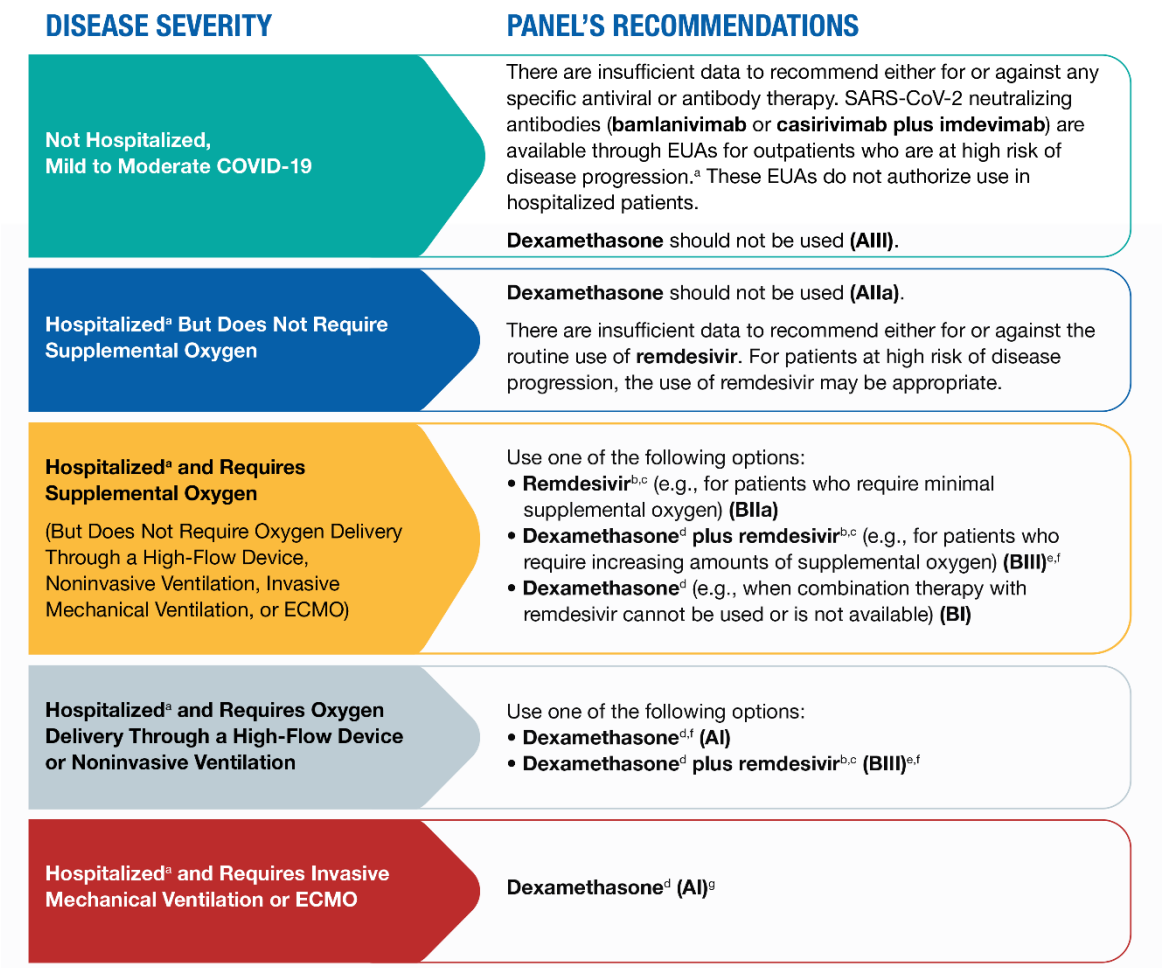
REUSE:

- Keep used respirators in a clean, breathable container such as a paper bag between uses. Do not store in a plastic bag. Keep in a clean space outside patient room such as a wall locker near patient's room or top of the isolation cart. To prevent accidental use of another person's respirator, label the container:
  - First initial and last name of owner
  - Strap of respirator with first initial and last name of owner
- Avoid touching the inside of the respirator. If inadvertent contact with the inside of the respirator, perform hand hygiene as described above.
- Use a pair of clean (non-sterile) gloves when donning a used N95 respirator and performing a user seal check. Discard gloves after the N95 respirator is donned and any adjustments are made to ensure the respirator is sitting comfortably on your face with a good seal.

Appendix C: Pharmacologic Management of Patients with COVID-19 Based on Disease Severity

Figure 1. Pharmacologic Management of Patients with COVID-19 Based on Disease Severity

Doses and durations are listed in the footnote.


DISEASE SEVERITY
PANEL'S RECOMMENDATIONS
Not Hospitalized, Mild to Moderate COVID-19
There are insufficient data to recommend either for or against any specific antiviral or antibody therapy. SARS-CoV-2 neutralizing antibodies (bamlanivimab or casirivimab plus imdevimab) are available through EUAs for outpatients who are at high risk of disease progression.[a] These EUAs do not authorize use in hospitalized patients.
Dexamethasone should not be used (AIII).
Hospitalized[a] But Does Not Require Supplemental Oxygen
Dexamethasone should not be used (AIIa).
There are insufficient data to recommend either for or against the routine use of remdesivir. For patients at high risk of disease progression, the use of remdesivir may be appropriate.
Hospitalized[a] and Requires Supplemental Oxygen
(But Does Not Require Oxygen Delivery Through a High-Flow Device, Noninvasive Ventilation, Invasive Mechanical Ventilation, or ECMO)
Use one of the following options:
• Remdesivir[b,c] (e.g., for patients who require minimal supplemental oxygen) (BIIa)
• Dexamethasone[d] plus remdesivir[b,c] (e.g., for patients who require increasing amounts of supplemental oxygen) (BIII)[e,f]
• Dexamethasone[d] (e.g., when combination therapy with remdesivir cannot be used or is not available) (BI)
Hospitalized[a] and Requires Oxygen Delivery Through a High-Flow Device or Noninvasive Ventilation
Use one of the following options:
• Dexamethasone[d,f] (AI)
• Dexamethasone[d] plus remdesivir[b,c] (BIII)[e,f]
Hospitalized[a] and Requires Invasive Mechanical Ventilation or ECMO
Dexamethasone[d] (AI)[g]
Rating of Recommendations: A = Strong; B = Moderate; C = Optional
Rating of Evidence: I = One or more randomized trials without major limitations; IIa = Other randomized trials or subgroup analyses of randomized trials; IIb = Nonrandomized trials or observational cohort studies; III = Expert opinion

[a] See the Panel's statements on the FDA EUAs for bamlanivimab and casirivimab plus imdevimab. These EUAs do not authorize use in hospitalized patients.

[b] The remdesivir dose is 200 mg IV for one dose, followed by 100 mg IV once daily for 4 days or until hospital discharge (unless the patient is in a health care setting that can provide acute care that is similar to inpatient hospital care). Treatment duration may be extended to up to 10 days if there is no substantial clinical improvement by Day 5.

[c] For patients who are receiving remdesivir but progress to requiring oxygen through a high-flow device, noninvasive ventilation, invasive mechanical ventilation, or ECMO, remdesivir should be continued until the treatment course is completed.

[d] The dexamethasone dose is 6 mg IV or PO once daily for 10 days or until hospital discharge. If dexamethasone is not available, equivalent doses of other corticosteroids, such as prednisone, methylprednisolone, or hydrocortisone, may be used. See the Corticosteroids section for more information.

[e] The combination of dexamethasone and remdesivir has not been studied in clinical trials.

[f] In the rare circumstances where corticosteroids cannot be used, baricitinib plus remdesivir can be used **(BIIa)**. The FDA has issued an EUA for baricitinib use in combination with remdesivir. The dose for baricitinib is 4 mg PO once daily for 14 days or until hospital discharge.

[g] The combination of dexamethasone and remdesivir may be considered for patients who have recently been intubated **(CIII)**. Remdesivir alone **is not recommended**.

Key: ECMO = extracorporeal membrane oxygenation; EUA = Emergency Use Authorization; FDA = Food and Drug Administration; IV = intravenous; the Panel = the COVID-19 Treatment Guidelines Panel; PO = orally; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2

Appendix D: Intravenous Medication Drips (Courtesy SMOG CY20)

KETAMINE (KETALAR)

Dosing Range: 15-50mcg/kg/min

MIX 500 mg/500 mL (NS or D5W)
CONCENTRATION = 1 mg/mL

Pt. Weight	Dose	Rate	Micro	Macro		
			60 gtt/mL	20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
80	15	72	72	24	18	12
	20	96	96	32	24	16
	25	120	120	40	30	20
	30	144	144	48	36	24
	35	168	168	56	42	28
	40	192	192	64	48	32
	45	216	216	72	54	36
	50	240	240	80	60	40

NOREPINEPHRINE (LEVOPHED) OR EPINEPHRINE (ADRENALINE)

Dosing Range: 2-20mcg/min

MIX 4 mg/500 mL (LR or D5W)
CONCENTRATION = 8 mcg/mL

Dose	Rate	Micro	Macro		
		60 gtt/mL	20 gtt/mL	15 gtt/mL	10 gtt/mL
mcg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
2	15	15	5	4	3
4	30	30	10	8	5
6	45	45	15	11	8
8	60	60	20	15	10
10	75	75	25	19	13
12	90	90	30	23	15
14	105	105	35	26	18
16	120	120	40	30	20
18	135	135	45	34	23
20	150	150	50	38	25

Appendix E ARDSNET Protocol (Courtesy ARDSnet CY08)

NIH NHLBI ARDS Clinical Network
Mechanical Ventilation Protocol Summary

INCLUSION CRITERIA: Acute onset of

1. $PaO_2/FiO_2 \leq 300$ (corrected for altitude)
2. Bilateral (patchy, diffuse, or homogeneous) infiltrates consistent with pulmonary edema
3. No clinical evidence of left atrial hypertension

PART I: VENTILATOR SETUP AND ADJUSTMENT

1. Calculate predicted body weight (PBW)
   Males = 50 + 2.3 [height (inches) - 60]
   Females = 45.5 + 2.3 [height (inches) -60]
2. Select any ventilator mode
3. Set ventilator settings to achieve initial V_T = 8 ml/kg PBW
4. Reduce V_T by 1 ml/kg at intervals ≤ 2 hours until V_T = 6ml/kg PBW.
5. Set initial rate to approximate baseline minute ventilation (not > 35 bpm).
6. Adjust V_T and RR to achieve pH and plateau pressure goals below.

---

pH GOAL: 7.30-7.45

Acidosis Management: (pH < 7.30)

If pH 7.15-7.30: Increase RR until pH > 7.30 or $PaCO_2$ < 25 (Maximum set RR = 35).

If pH < 7.15: Increase RR to 35.
If pH remains < 7.15, V_T may be increased in 1 ml/kg steps until pH > 7.15 (Pplat target of 30 may be exceeded).
May give $NaHCO_3$

Alkalosis Management: (pH > 7.45) Decrease vent rate if possible.

I: E RATIO GOAL: Recommend that duration of inspiration be ≤ duration of expiration.

PART II: WEANING

A. Conduct a SPONTANEOUS BREATHING TRIAL daily when:

1. $FiO_2 \leq 0.40$ and PEEP ≤ 8 OR $FiO_2 \leq 0.50$ and PEEP ≤ 5.
2. PEEP and FiO_2 ≤ values of previous day.
3. Patient has acceptable spontaneous breathing efforts. (May decrease vent rate by 50% for 5 minutes to detect effort.)
4. Systolic BP ≥ 90 mmHg without vasopressor support.
5. No neuromuscular blocking agents or blockade.

OXYGENATION GOAL: PaO_2 55-80 mmHg or SpO_2 88-95%
Use a minimum PEEP of 5 cm H_2O. Consider use of incremental FiO_2/PEEP combinations such as shown below (not required) to achieve goal.

Lower PEEP/ higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

Higher PEEP/ lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

PLATEAU PRESSURE GOAL: ≤ 30 cm H_2O
Check Pplat (0.5 second inspiratory pause), at least q 4h and after each change in PEEP or V_T.
If Pplat > 30 cm H_2O: decrease V_T by 1ml/kg steps (minimum = 4 ml/kg).
If Pplat < 25 cm H_2O and V_T< 6 ml/ kg, increase V_T by 1 ml/kg until Pplat > 25 cm H_2O or V_T = 6 ml/kg.
If Pplat < 30 and breath stacking or dys-synchrony occurs: may increase V_T in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains ≤ 30 cm H_2O.

B. SPONTANEOUS BREATHING TRIAL (SBT):
If all above criteria are met and subject has been in the study for at least 12 hours, initiate a trial of UP TO 120 minutes of spontaneous breathing with FiO2 ≤ 0.5 and PEEP ≤ 5:

1. Place on T-piece, trach collar, or CPAP ≤ 5 cm H_2O with PS ≤ 5
2. Assess for tolerance as below for up to two hours.
   a. $SpO_2 \geq 90$: and/or $PaO_2 \geq 60$ mmHg
   b. Spontaneous $V_T \geq 4$ ml/kg PBW
   c. RR ≤ 35/min
   d. pH ≥ 7.3
   e. No respiratory distress (distress= 2 or more)
      - HR > 120% of baseline
      - Marked accessory muscle use
      - Abdominal paradox
      - Diaphoresis
      - Marked dyspnea
3. If tolerated for at least 30 minutes, consider extubation.
4. If not tolerated resume pre-weaning settings.

Definition of UNASSISTED BREATHING
(Different from the spontaneous breathing criteria as PS is not allowed)

1. Extubated with face mask, nasal prong oxygen, or room air, OR
2. T-tube breathing, OR
3. Tracheostomy mask breathing, OR
4. CPAP less than or equal to 5 cm H_20 **without pressure support or IMV assistance.**

Appendix F: Oxygen Generator Guide

Medical Oxygen Generator (MOG)

Otherwise known as Expeditionary Deployable Oxygen Concentrator System (EDOCS). EDOCS is designed to provide 120Lpm of 93 percent oxygen and medical grade compressed air for patients, anesthesia machines, and mechanical ventilators. It can also be used to fill high pressure oxygen cylinders up to 2250 psig.

Fills cylinders to 2250 PSIG using M Cylinder Charging Station:

- "H" (6000 L) Cylinder 4.5 Minutes
- "D" (370 L) Cylinder 4x 60 Minutes
- "E" (620 L) Cylinder 4x 60 Minutes

Portable Oxygen Generator System (POGS)

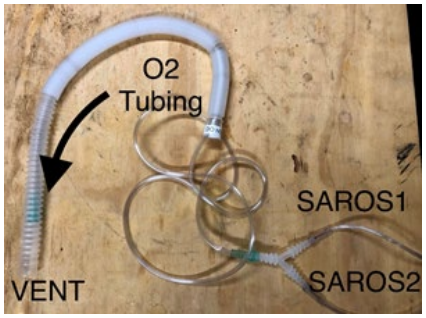
The Portable Oxygen Generation System (POGS 33) is designed to provide 33Lpm of 93 percent oxygen and medical grade compressed air for patients, anesthesia machines, and mechanical ventilators. It can also be used to fill high pressure oxygen cylinders up to 2200 psig.

Fills cylinders to 2200 PSIG with Micro Boost / HV Booster:

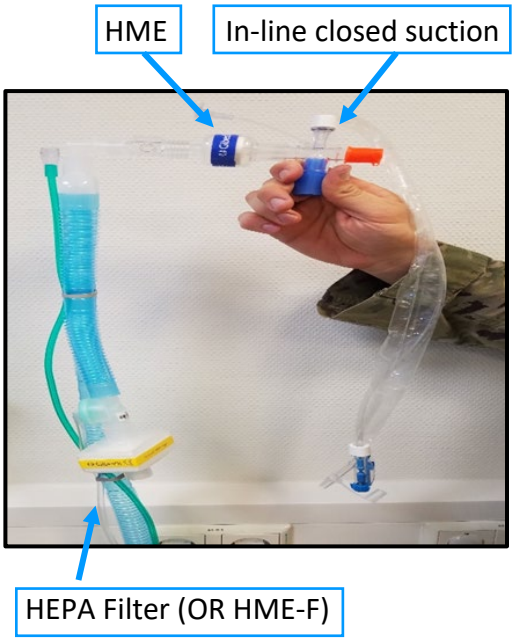
- "H" (6000 L) Cylinder not possible / 3 Hours with HV Booster
- "D" (370 L) Cylinder 52 Minutes / 12 Minutes with HV Booster
- "E" (620 L) Cylinder 1.5 Hours / 19 Minutes with HV Booster

Oxygen Generator Field Portable (OGFP)

Otherwise known as SAROSTM Oxygen System. OGFP is a small, battery operated oxygen concentrator used to provide low flow (up to 3Lpm) of continuous oxygen support for combat casualties. The oxygen support can be increased by filling an oxygen reservoir using two devices (as pictured below).



Appendix G: EMV+ 731 Ventilator Set-Up Guide



*For austere set-up the, simply inserting one HME-F filter between the ETT and ventilator tubing circuit is good enough. (See Appendix H.)

Recommended Items:

Tubing: Circuit Vent Single Limb WYE Adult/Pedi 1S
MFG: Zoll Medical MFG CAT #: 820-0106-00

Closed In Line Suction: In Line Suction 20S 12F
MFG: Smith Medical/Meditrade MFG CAT #: Z210-12

Heat Moisture Exchange: Humid-Vent 2S up to 1500ML
MFG: TELEFLEX MFG REF #: 14412

End Tidal CO_2 Adapter: Adapter Airway Disposable Zoll
MFG: Zoll Medical MFG CAT #: 8000-0260-01

Oxygen Hose: Hose ASB Cond 6FT OXY DIS HEX NUT
MFG: AMVEX MFG REF #: HS06ODFDF

HEPA Filter: ISO-GARD HEPA Light Filter (Machine)
MFG: Teleflex MFG REF #: 28022

OR

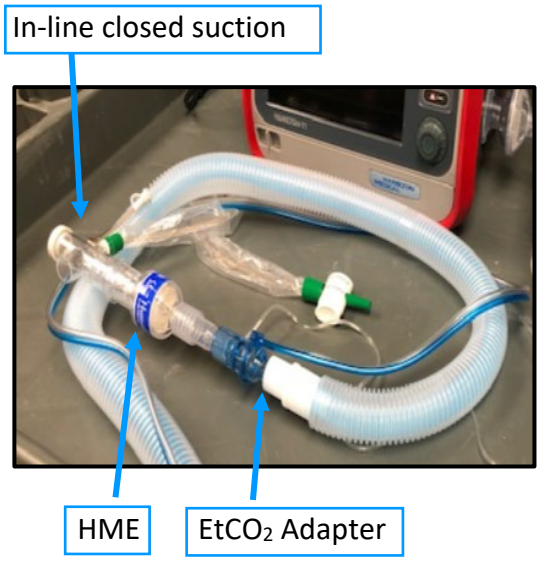
HME-F: Filter Humid-Vent Compact up to 1000ML
MFG: Teleflex MFG REF #: 19402

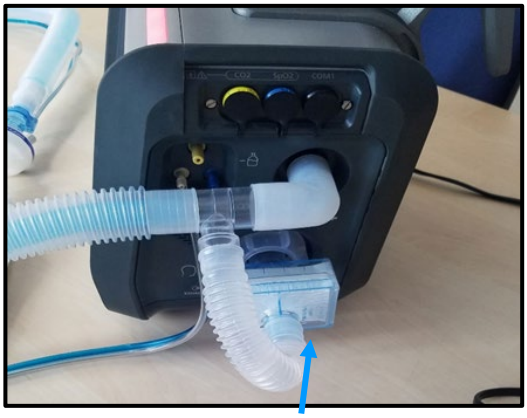
Order of Assembly:
ETT>>In-Line Suction>>HME>>End-Tidal CO_2 Adapter>>Tubing>>Ventilator

Additional Considerations:

1. Reference JTS Acute Respiratory Failure CPG for initial settings and ARDSnet protocol card for adjustment.
2. ETT should be temporarily clamped with a padded hemostat during any circuit break.
3. HME (or HME-F) should be placed in the inspiratory limb to humidify gas delivered to patient.
4. HEPA filter (or HME-F) should be placed at the end of the expiratory limb to minimize viral aerosol.
5. HEPA filter (or HME-F) should be placed in the air inlet to mitigate device contamination.
6. A BVM connected to oxygen supply with viral filter and PEEP valve should always be available!
7. Oxygen hose should be connected directly to 50psi oxygen source (e.g., D-cylinder), NOT to a flow meter!

Appendix H: Hamilton T1 Set-Up Guide





** For austere set-up the, simply inserting one HME-F filter between the ETT and ventilator tubing circuit is good enough (see Appendix I)*

Recommended Items:

Tubing: Breathing Circuit Set, COAXIAL
MFG: Hamilton PART #: 260240

Closed In Line Suction: In Line Suction 20S 12F
MFG: Smith Medical/Meditrade MFG CAT #: Z210-12

Heat Moisture Exchange: Humid-Vent 2S UP TO 1500ML
MFG: Teleflex MFG REF #: 14412

End Tidal CO2 Adapter: Adapter Airway Disposable Zoll
MFG: Zoll Medical MFG CAT #: 8000-0260-01

Oxygen Hose: Hose ASB Cond 6FT OXY DIS HEX NUT
MFG: AMVEX MFG REF #: HS06ODFDF

HEPA Filter: ISO-GARD HEPA Light Filter (Machine)
MFG: Teleflex MFG REF #: 28022

OR

HME-F: Filter Humid-Vent Compact up to 1000ML
MFG: Teleflex MFG REF #: 19402

Order of Assembly:
ETT>>In-Line Suction>>HME>>End-Tidal CO_2 Adapter>>Tubing>>Ventilator

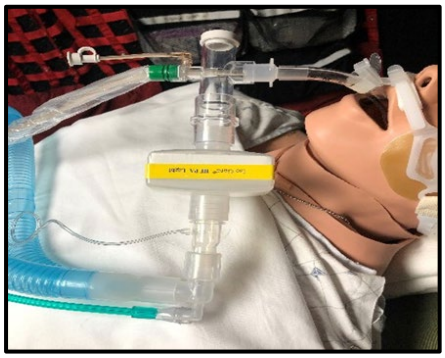
Additional Considerations:

1. Reference JTS Acute Respiratory Failure CPG for initial settings and ARDSnet protocol card for adjustment.
2. The mode should be set at "(S)CMV+"
3. ETT should be temporarily clamped with a padded hemostat during any circuit break.
4. HME (or HME-F) should be placed in the inspiratory limb to humidify gas delivered to patient.
5. HEPA filter (or HME-F) should be placed at the end of the expiratory limb to minimize viral aerosol.
6. A BVM connected to oxygen supply with viral filter and PEEP valve should always be available!
7. Oxygen hose should be connected directly to 50psi oxygen source (e.g., D-cylinder), NOT to a flow meter!

Appendix I: BVM and SAVe II Set-Up Guide

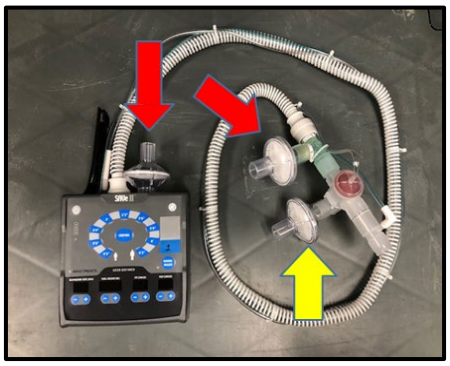
For Bag-Valve Mask Ventilation (BMV):

ETT (or Mask)>>HEPA (of HME-F)>>End-Tidal CO_2 Adapter (optional)>> AMBU Bag (with PEEP valve)
*Microorganism filters minimize viral aerosol formation
**PEEP valves are critical supply for acute lung injury
***End-Tidal CO_2 adapter is optional



For Circuit using only one HME-F:

ETT>>In-Line Suction>>HEPA (or HME-F)>>End-Tidal CO_2 Adapter (optional)>>Tubing>>Ventilator
*HME will NOT minimize viral aerosol formation
**Must be HEPA or HME-F microorganism filter
***End-Tidal CO_2 adapter is optional



For SAVe II Ventilator Set-up:

For the SAVe II ventilator, 3 filters are necessary. The red arrows mark where room air is entrained into the circuit. The yellow arrow shows the exhalation valve.
*Manufacturer does not recommend using this device in contaminated environments
**The debris filter is designed to stop particulates, not chemical or biological agents
***End-Tidal CO_2 adapter is optional

Appendix J: Preparation for Transport Checklist (courtesy SMOG CY20)

PRE-FLIGHT CHECKLIST

(for Critical Care and Post-Surgical Transfers)

Once the decision is made to transfer a patient and an accepting physician has been obtained, the following steps will be taken to prepare the patient for transport:

Initials	Evaluation Steps
	1. Sending location/physician: _____Accepting location/physician:_____ Flight nurse called: name / time: _____
	2. Anesthesia called: intubation if indicated. ETT secured/marked
	3. Patient meets criteria for en route critical care transport: risk documented by sending physician (POST-OPERATIVE and CC INTRAFACILITY TRANSFER, Pre-Transfer Patient Status Requirements)
	Preparation Steps
	Positioning and Proper Monitoring:
	1. Patient moved to litter (collapsible handles), positioned, padded, strapped, equipment (with necessary attachments) added and secured.
	2. For head-injured patients, a pre-sedation neurologic examination will be performed. GCS and neurological exam documented on the en route care form, suggest placing patient sitting at 30°-45°.(For eye injured patients, fox shield in place. For burn patients, JTS burn sheet initiated.)
	3. Ventilator switched to PMI vent at least 20-30 min prior to flight and set with transfer settings ordered by physician.
	4. IV / IO access verified, patent, and secured.
	5. Arterial line inserted and secured, if indicated. Transducer accessible.
	6. Ventilator tubing checked to be free from obstruction, with $ETCO_2$ and secondary lines attached.
	7. Orogastric or nasogastric tube is inserted (unless contraindicated), placement verified with chest x-ray, and attached to low-intermittent suction.
	8. Chest tubes to water seal/suction (place Heimlich valve for non-atrium chest drainage systems).
	9. Wound vacuum disconnected and stowed.
	10. Foley catheter secured, urine output measured and documented.
	Equipment, Medication, Chart, and Personnel Preparation:
	11. Medications needed for flight prepared and organized.
	12. Flight equipment bag obtained and checked. Backup pulse oximeter readily available.
	13. Complete chart photocopied (including x-ray cd), patient belongings bagged and tagged. Transfer Document, or other theater / unit approved transfer document, has been initiated.
	14. Earplugs and eye protection for patient and flight nurse.
	15. If facility sends medical attendant, attendant must have relevant personal protective equipment. In a combat environment this includes: Uniform, Kevlar, IBA, Weapon, ID Card, and equipment for transport.
	Ventilator Management:
	16. Blood gas (preferably ABG) obtained, 15 min after initial settings and ventilator changes. All efforts will be made to have a documented blood gas within 30 minutes prior to flight time.
	17. Adjust ventilator settings and check O_2 tank for length of flight. Resuscitator bag under patient's head with tubing connected to O_2 source, vent tubing free from obstruction.
	Final Verification:
	18. Transferring Physician, Flight Paramedic, ECCN (or Flight Provider) verbally agrees to flight care plan.
	19. Critical Care Transfer Orders reviewed and signed by transferring physician.(STANDARD ORDER SET for CRITICAL CARE TRANSFERS)
	20. Enroute CC Transfer Document with completed preflight and enroute care data handed over to and confirmed by receiving provider / facility.

Appendix K: Virtual Critical Care Call (Vc3) Script (Courtesy PFC Group CY17)

Virtual Critical Care Consultation(VC3) Guide- Page 1

VIRTUAL CRITICAL CARE CONSULTATION (VC3) GUIDE – 8 July 2017 (v3)
To be used with Prolonged Field Care Card

1. Before calling, E-mail image of the casualty (wounds, environment, etc.), "capabilities" (back of page), & vital signs trends to dod.VC3@mail.mil
2. If call not answered: a) call next number on PACE or b) call back in 5 – 10 min.
3. If unable to provide information due to operational security, state so.

P: Commercial: **+1 (210) 916 – VCCC (8222)**, DSN: **(312) 429 – 8222** **(TELE-CRITICAL CARE CONSULTATION)**
A: Commercial: **+49 6371 – 9464 – 7141**, DSN: **(314) 590 – 7141** **(LRMC ICU, ASK FOR ON-CALL PHYSICIAN)**
C:
E:

This is _____ I am a (job/ position) _____
My best contact info is: _____
YOUR best contact info is (Consultant's number): _____Alternate e-mail: _____

*** PAUSE POINT to CONFIRM CONTACT INFO***

I have a _____ year–old _____(sex) _____ (active duty/foreign national/OGA,etc.), who has the following:
Mechanism of Injury or known diagnosis(es)
The injury/start of care occurred *hours ago*. Anticipated evacuation time is (*hours* from now):
Injuries/Problems/Symptoms:

Treatments:

He/she is currently (circle) stable/ unstable, getting better/ getting worse/ getting worse rapidly
Known Medication Allergies/Past medical/Surgical history is:

I need help with (*be specific if possible, i.e. "I need help reading this ECG," or "I need help stabilizing this patient," etc.)*

Other Consultants have recommended:

*** PAUSE POINT for Remote Consultant to ask clarification questions ***

VITALS (*current* & *trend* as of): HR BP RR SpO2 $EtCO_2$ Temp
UOP(ml/hr) over (# hours) Mental Status (GCS/ AVPU)
EXAM: Neuro Ext/ MSK
Heart Pulses
Lungs Skin/ Wounds
Abd
LABS: ABG: Lactate: Other:

*** PAUSE POINT for Remote Consultant to ask clarification questions ***

Virtual Critical Care Consultation (VC3) Guide-Page 2

Plans/Recommendations

PRIORITY	SYSTEM/PROBLEM	RECOMMENDATION
	Neuro or problem #1	
	CV or problem #2	
	Pulm or problem #3	
	GI or problem #4	
	Renal or problem #5	
	Endocrine or problem #6	
	MSK/ Wound or problem #7	
	Tubes, lines, drains or problem #8	
	Prophylaxis/prevention or prob#9	
	Other	

TO-DO/ FOLLOW-UP/TO-STOP	NOTES
1.	
2.	
3.	
4.	
5.	
6.	

*** PAUSE POINT, for Medic/Local Caregiver to ask clarification questions/READBACK***

Available "kit" (supplies, equipment, medications) !! IF POSSIBLE PHOTOGRAPH AND SEND VIA EMAIL BEFORE CALLING !!

Commo: Tempus i2i ID: _____ SAT#/Local Cell# _____
Other (FaceTime, VSee, Skype, WhatsApp ,etc.): _____
IV access: IV Central line IO (location) Other: _____
Monitor: Propaq Tempus Foley Graduated urinal PulseOx only Exam Only
Other: _____
IV Fluids: Plasma-Lyte LR Normal Saline 3% saline Other: _____
Colloids: Hetastarch Albumin Other: _____
Blood products: Whole blood PRBC Plasma FDP Platelets Other: _____
Medications: Antibiotics: name/route/dose _____
Morphine IV/ PO Other opioid (name/ IV/ PO): _____
Fentanyl IV/ PO (pop) Ketamine
Midazolam Diazepam (IV/ PO)
TXA Other(s): _____
Airway/Breathing: ETT Cric kit LMA BVM O2 Suction (type): _____Ventilator(model): _____
Miscellaneous:

Appendix L: Minimum, Better, Best - Equipment and Supplies

Problem	Minimum	Better	Best
PPE	See Appendix on PPE, varies with intensity of exposure		
Testing	Malaria Rapid Diagnostic Testing (in endemic areas)	Plus: Ultrasound device 12-Lead ECG Influenza & Dengue Rapid Tests POCT Blood Gas POCT Glucometer	Above plus: Chest X-Ray COVID-19 PCR Testing Respiratory Pathogen Film Array Other testing per DOD COVID PMG Other clinically indicated testing
Oxygen Supply	Oxygen Generator Field Portable (SAROS™)[a]	Plus: Compressed oxygen cylinders	Plus: Oxygen Generating System
Ventilator	Bag-Valve-Mask Ventilation with PEEP valve, HEPA Filter (or HME-F), and oxygen supply	Rescue Ventilator (SAVe II)	Transport Ventilator (EMV+ 731 or Hamilton T1)
In-line Filter Placement (Appendices E, F, G)	HME-F (or HEPA Filter) at Y-Piece between ETT and ventilator tubing	Plus: HME/HME-F at Y-Piece and HEPA Filter in exhalation limb	Plus: In-line Heated Humidification Device (i.e. Hamilton H900)
Monitoring	Pulse Oximeter, Manual BP Cuff, Physical Exam Document trends using PFC Flowsheet or similar	Plus: End-Tidal Capnometry	Plus: Continuous cardiac monitoring Invasive arterial pressure monitoring
IV Drips	Drop counting (Drip Chamber)	In-line Dial-A-Flow device	IV Pump
Medications	Ketamine Midazolam Acetaminophen Ertapenem[b]	Plus: Etomidate Vecuronium Fentanyl Epinephrine Ceftriaxone Azithromycin Ondansetron	Plus: Desmedetomidine Propofol Norepinephrine Rocuronium Levofloxacin IV Glucocorticoid[c] Vasopressin
Airway	Laryngeal Mask Airway (Cricothyroidotomy for emergent cases)	Direct Laryngoscopy	Video Laryngoscopy
Secretion Management (not including HMEs)	Positioning Chest Percussion Bulb Suction	Plus: Bronchodilators 3% Saline[d] Suction device	Plus: N-Acetylcystine[d] Consider anti-sialagogues[e]
VTE Prophylaxis	Ambulation[f]	Range of Motion Exercises Extremity Massage	Low Molecular Weight Heparin or Unfractionated Heparin

a - While compressed gas cylinders are more widely fielded than OGFP/SAROS systems, the prolonged need for oxygen requires an emphasis on being able to supply O_2 for a prolonged period of time.
b - Ertapenem is a widely fielded broad spectrum antibiotic with adequate activity against common organisms causing community acquired pneumonia. Ertapenem is not necessary (for CAP) if antibiotics specific for CAP are available.
c - Methylprednisolone (Solu-medrol), Hydrocortisone (Solu-cortef), or Dexamethasone.
d - Require pre-treatment with a bronchodilator to avoid bronchospasm.
e - Anti-sialagogues are of uncertain benefit; consider telehealth consultation before use.
f - Patients that are able to ambulate or at least perform bedside exercises are encouraged to do so. Non-graduated compression stockings or circumferential ACE wraps are NOT encouraged given risk for venous compression and stasis with higher risk for thrombosis.

Appendix M: Example Equipment Checklists

Durable Equipment Kept On Standby		
□ Litter Stanchions (or fabricated stands)	□ Power Strips / Extension cord	□ Hemodynamic Monitoring Equipment
□ NATO or Talon Litter	□ EMV+ 731 (or Hamilton T1) with charger	□ Infusion Pumps with extra battery and charging cable
□ Mattress pad, inflatable sleeping pad, or Warrior Evacuation Litter Pad	□ Portable Suction Unit with charger	□ Ultrasound with phased array and linear probes
□ 3x blankets or large pillows for offloading pressure points	□ D-Cylinder(s) with regulator, wrench, and high pressure tubing	□ Video-laryngoscope (e.g., GlideScope) and rigid intubating stylet
□ 550 Cord for hanging drips	□ Oxygen Generator Field Portable (i.e. SAROS) with charger	□ i-STAT with several cartridges

Intubation & Ventilator Kit		
□ Bag-Valve Mask	□ GlideScope Sheath, Size 4	□ Tube Securement (e.g. Hollister AnchorFast, Thomas Tube Holder)
□ Non-Rebreather Mask	□ GlideScope Sheath, Size 3	□ Yankauer with Suction Tubing
□ HME-Filter (1x for BVM, 1x for Vent)	□ GlideScope Stylet	□ 18fr Salem Sump NG/OGT
□ Color-Capnometer OR $EtCO_2$ monitor adapter	□ Direct Laryngoscope handle with batteries	□ 60mL Toomey Syringe
□ ETT, 7.0mm ID	□ Macintosh DL blade, size 3 or 4	□ Large Hemostat for clamping ETT
□ ETT, 8.0mm ID	□ Miller DL blade, size 2	□ In-line suction adapter
□ 10mL Syringe	□ Flexible Stylet	□ Ventilator Tubing
□ Airway Introducer (a.k.a. Bougie)	□ LMA, iGel size 4 OR standard LMA	
□ Cricothyroidotomy Kit	□ Tongue Depressor	

Central Line Placement Kit (if within scope of practice)	
□ Appropriately sized surgical gloves	□ 1x Clear Occlusive Dressing (i.e. Tegaderm)
□ 2x ChloraPrep or Povidone-Iodine swabs	□ 1x Cordis Introducer Catheter Kit
□ 1x Needleless Port (a.k.a. Posi-Flow Valves)	□ 1x Surgical Drape (if not included in kit)

Arterial Line Placement Kit (if within scope of practice)		
□ Appropriately sized surgical gloves	□ 1x Straight Needle with 2-0 Silk Suture	□ 1x VAMP Pressure Transducing Tubing
□ 2x ChloraPrep or Povidone-Iodine swabs	□ 2x 4x4 Gauze Packets	□ 1x Pressure Bag (500mL)
□ 2x ARROW Radial Arterial Line 'Dart'	□ 1x Clear Occlusive Dressing (i.e. Tegaderm)	□ 1x 500mL Normal Saline

Medication Administration Kit		
□ 4x Peripheral IV Start Kit*	□ 2x 500mL Normal Saline (carrier fluid)	□ 10x 10mL Syringes
□ 4x Primary IV Tubing, 10gt	□ 2x 250mL Normal Saline (for drips)	□ 10x 5mL Syringes
□ 20x Alcohol Swabs	□ 4x 100mL Normal Saline (for drips)	□ 20x 10mL Saline Flush
□ 1x 1" Tape Roll	□ 2x 1000mL Lactated Ringers (for bolus)	□ 20x 18g Needles

Additional Equipment (Foley, Pneumothorax Management, Nursing Care)	
□ Foley Catheter Kit (e.g. Bard or Chinook prepackaged kits)	□ Wet Wipes (for bed-baths)
□ 4x 14g 3.125 inch needle-catheters for chest decompression	□ Absorbent pads (a.k.a. chux)
□ Chest Tube Kit*	□ Bedsheet or HPMK as drawsheet
□ 1x Chest Drainage System (e.g. Atrium or Pleur-evac; water seal preferable over Heimlich valve to prevent excessive aerosol formation)	

* Seldinger technique smaller bore chest tube kits (e.g. Thal Quick or Cook 14fr catheters) can be used for atraumatic pneumothorax; however, these are more procedurally complicated and not usually available in austere locations.

MECHANICAL VENTILATION DURING CRITICAL CARE AIR TRANSPORT (CCAT) CLINICAL PRACTICE GUIDELINE

Publication date: 12 Oct 2013
Certified current by the U.S. Air Force Mobility Command as of 14 Dec 2021

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I. Background & Introduction

1. Mechanical ventilation can injure the lung. Appropriate ventilator strategies will minimize ventilator induced lung injury.
2. Lung protective ventilation is appropriate for most CCAT patients, even if they do not have Acute Respiratory Distress Syndrome (ARDS).
    a. The same pathophysiologic processes are likely at work, even if they have not reached a level that meets the formal ARDS definition.
    b. There is evidence that lung protective ventilation decreases ARDS development in patients at risk, which describes most CCAT patients.
3. This document closely follows the ventilation strategy from the ARDS Network ARMA trial.
    a. This is the least harmful strategy formally studied and validated in a large trial.
    b. Some experts may choose to deviate from the strategy in an individual patient.
    c. The strategy has been modified in some respects to simplify its use.

II. Determining Stability for Flight

1. Stability for flight is a multi-factorial decision based on the patient, sending facility, CCAT team, and flight characteristics.
2. Patient characteristics
    a. PEEP and FIO2
        i. PEEP / F_IO_2 greater than 14/70% (See Appendix B.) should prompt careful consideration of risks and benefits. Such patients have little room to increase F^IO_2 or mean airway pressure if their condition worsens during flight. This does not mean patients on these settings cannot be transported safely.
        ii. All patients, including those on mechanical ventilation, will experience a decrease in PO2as ambient pressure decreases.
            - Patients with marginal gas exchange will require additional support during flight.
            - Cabin altitude restriction will lessen the impact on gas exchange.
    b. Patients on aggressive support that has been stable over time are better candidates for transport than those with increasing support leading up to flight time.
    c. Concurrent hemodynamic compromise or traumatic brain injury will complicate ventilator management and should be considered in assessing stability for flight.
3. Sending facility characteristics
    a. Type of ventilators available
    b. Availability of rescue therapies (proning, inhaled nitric oxide/prostacyclin, advanced mechanical ventilation techniques, etc.)
    c. Personnel experience and expertise

   d. Current beds available and anticipated casualties
4. Expertise of CCAT team members with advanced mechanical ventilation strategies
5. Flight characteristics
   a. Flight duration
   b. Aircraft type
   c. Patient load and complexity
   d. Altitude restriction

III. Pre-flight Preparation

Ventilator

1. Most patients can be safely transported using the Impact 731 ventilator.
   a. Allows for volume control or pressure control ventilation.
   b. Altitude compensated.
   c. Rated for patients 5kg and above.
   d. Cannot do inverse ratio.
2. The LTV 1000 ventilator offers additional capability needed in some patients but also has limitations.
   a. Inverse ratio ventilation.
   b. Better choice for pediatric transports.
   c. Unable to compensate for altitude.
   d. Unable to achieve 100% Fi02 due to turbine (93-94% highest FiO_2 attainable).

Oxygen

1. Oxygen requirements should be calculated for all patients.
   a. The LTV 1000 with high F_IO_2 and minute ventilation can exhaust a full Portable Therapeutic Liquid Oxygen System (PTLOX) during along mission. Never forego the oxygen calculation.
   b. Refer to Appendix A.
      - There is no safety factor in the calculations.
      - Additional oxygen beyond calculated requirement should be determined by each team on a case by case basis based on patient and transport characteristics.
2. Each mechanically ventilated patient should ideally have a dedicated PTLOX.
3. It is possible to have two patients on one PTLOX; Aeromedical Evacuation will make that determination if necessary.

Patient Preparation

1. Note endotracheal (ET) tube depth at the teeth that correlates to appropriate placement by CXR.
2. Secure ET tube using a dedicated securing device.
    a. If burns or facial trauma preclude this, consider securing tube to upper central incisor using silk suture or wire.
    b. Be certain that lips and tongue are not injured by device.
3. Avoid exposing airway to atmospheric pressure during ventilator changeover if PEEP is ≥ 10cm H_2O.
    a. Lung de-recruitment occurs rapidly with exposure to atmospheric pressure.
    b. Gently clamp ET tube using a Kelly clamp while the circuit is broken for ventilator changeover.
    c. Pad the Kelly clamp with tape or short pieces of rubber tubing to avoid damage to the ET tube.
    d. Do not clamp wire reinforced tubes as they will kink permanently.
4. All ventilated patients should have a heat-moisture exchanger in place.
5. Check ET tube cuff pressure prior to departure.
    a. Proper ET tube cuff inflation is mandatory to avoid aspiration, de-recruitment and ventilator malfunction (pressure too low) or damage to tracheal mucosa (pressure too high).
    b. Palpating ET tube cuff is inaccurate and should not be relied upon to estimate cuff pressure. ***Use a cuff manometer***.
    c. Goal is 20 – 30 cm H_2O (15-22 mm Hg).
    d. ET tube cuffs should be filled with air. Do not use saline.
6. All ventilated patients should have the head of bed elevated at least 30° unless there is a contraindication.
    a. Most patients will not have a contraindication. Ask the sending physician or neurosurgeon for clarification if necessary.
    b. The backrest designed for the NATO litter is the most appropriate way to elevate the head of bed.
7. All ventilated patients should have continuous $ETCO_2$ monitoring.
    a. Use caution interpreting the absolute value as it may not accurately reflect $PaCO_2$.
        - The difference between $PaCO_2$ and $ETCO_2$ reflects dead space, which can change rapidly in critically ill patients.
        - There is also likely to be some measurement error.
    b. The true value is the ability to immediately detect circuit disconnections and ventilator failures by observing changes in the waveform and to identify trends in CO_2 that may prompt arterial blood gas measurement.
    c. Providers skilled with $ETCO_2$ monitoring may infer hemodynamic data from $ETCO_2$ data.
8. All ventilated patients require gastric decompression prior to flight. Oro-gastric tube preferred to naso-gastric tube to prevention sinusitis.

9. Consider repeat CXR if > 12 hours has elapsed since most recent one or clinical condition has changed significantly.
10. Tube feeds not administered through a small bowel feeding tube should be discontinued prior to flight.

IV. Basic Ventilator Management

Mode of Ventilation

1. Avoiding injurious ventilator settings is far more important than the mode of ventilation.
2. There is no outcome based evidence favoring one mode of ventilation over another.
3. Patients in the landmark ARDSNet ARMA trial were all ventilated in volume control ventilation.
4. Pressure control has some theoretical advantages:
   - Decelerating flow waveform is more comfortable and may improve gas mixing.
   - Inverting I:E ratio is an option for increasing the mean airway pressure that is not available on the Impact 731.

Ventilator Settings

1. Tidal Volume (V_T)
   a. If using volume control:
      i. Start with V_T at 6 cc/kg
      ii. Decrease V_T as needed to achieve peak inspiratory pressure (PIP) ≤ 35 (preferably ≤30)
      iii. Do not go below V_T = 4 cc/kg.
   b. If using pressure control:
      i. Start with PIP 30-35 cm H_2O.
         - The difference between PEEP and PIP will determine V_T and is known as driving pressure or ΔP.
         - Changes in PEEP or PIP without concomitant changes in the other will change ΔP, thereby changing V_T.
      ii. Incrementally decrease ΔP (by decreasing PIP and/or increasing PEEP) as needed to achieve V_T = 6 cc/kg.
      iii. It is acceptable to target a V_T as low as 4 cc/kg if required to maintain PIP ≤ 30 - 35cm H_2O.
   c. Tidal volume should be based on predicted body weight (PBW) according to: PBW = 50+2.3 (height in inches – 60) for males. Refer to Appendix B.
   d. V_T = 8 cc/kg is acceptable in spontaneously breathing patients who are fighting the ventilator as long as the PIP or set pressure remains ≤35 (preferably ≤ 30).
   e. Do not increase tidal volume to control pCO_2.

2. Respiratory Rate
    a. Respiratory rate should be 6 – 35
    b. Adjust to achieve pH ≥ 7.3
    c. The actual pCO_2 is not important, only the pH. ******Not applicable to TBI patients******
        - Respiratory acidosis is typically very well tolerated.
        - Trying to normalize pCO_2 will worsen ventilator induced lung injury.
3. PEEP and FIO2
    a. Set initial PEEP and F_IO_2 based on MTF settings or your best estimate of what the patient needs. Minimum PEEP is 5 cm H_2O.
    b. Titrate PEEP and F_IO_2 to achieve SaO_2 92 – 96% according to the ARDSNet ARMA table in Appendix B.
    c. Recheck PIP and V_T after any change in PEEP. Adjust V_T or ΔP as needed.
        i. Increasing PEEP may increase PIP and necessitate decreasing V_T in volume control ventilation.
        ii. The LTV 1000 and 731 ventilators are not PEEP compensated.
            - Increasing PEEP without a concomitant increase in PIP will decrease ΔP and V_T.
            - Decreasing PEEP without a concomitant decrease in PIP will increase ΔP and V_T.

Alarms

1. Alarms should be set to alert the team to malfunctions or changes in physiology without causing frequent false alarms. The following guidance is a starting point but each team will determine appropriate alarm settings for each mission.
2. Suggested initial settings
    a. High pressure alarm should be set 50% above the baseline PIP (1.5 X current PIP).
    b. Low pressure alarm should be set 50% below the baseline PIP (0.5 X current PIP).
    c. High respiratory rate alarm (731 only) should be set 10 above the patient's respiratory rate.
    d. Low respiratory rate alarm (731 only) should be set 10 below the set rate.
    e. Minute ventilation alarm (LTV 1000 only) should be set 50 % below the baseline minute ventilation (0.5 X current minute ventilation)

V. Ongoing Management

Airway Suctioning

1. Suctioning every 4 hours is appropriate without copious secretions or mucous plugging.
2. Frequent suctioning may lead to lung de-recruitment and worsen gas exchange in patients with ARDS.

ET Tube Cuff Pressure

1. Significant changes may occur on ascent and descent (pressure increases with ascent, decreases with descent).
2. Pressure should be checked and documented with manometer before departure, at cruise altitude, during descent and after landing.

Mouth Care

1. Regular mouth care decreases the ventilator associated pneumonia risk.
2. Chlorhexidine is the preferred agent.
3. Recommended frequency is every 4 hours, workload permitting. Document on 3899.

Monitoring and Adjusting Ventilator Settings

1. Lung mechanics and gas exchange may change considerably during a long transport.
2. It is imperative to monitor for changes and adjust ventilator settings to meet mechanical ventilation goals.
3. Excessive V_T and inspiratory pressures are harmful and should be corrected when they are identified.
   - In volume control ventilation, incrementally change V_T by 50 cc's every 10 minutes until the desired values are achieved.
   - In pressure control ventilation, incrementally change PIP by 2 cm H_2O every 10 minutes until the desired values are achieved.
4. SaO_2 should be maintained 92 – 96% by titrating F_IO_2 and PEEP according to the ARDSNet ARMA table.
   a. F_IO_2 can be weaned up or down rapidly as any adverse effects can be quickly remedied by reversing the change.
   b. PEEP decreases
      - Rapid decreases may cause lung de-recruitment that is harmful and difficult to reverse.
      - Decrease by no more than 3 cm H_2O in a six-hour period.
   c. PEEP increases
      - Increasing PEEP can decrease cardiac output by decreasing venous return to the heart.
      - Volume loading may be needed as PEEP increases, especially when PEEP exceeds 10cm H_2O.

Management of Oxygen Desaturation

1. Confirm ET tube is in trachea using $ETCO_2$.
2. If desaturation is severe switch immediately to manual bag ventilation with high flow oxygen and PEEP valve.
3. Exclude equipment malfunction, loss of O2 supply, circuit disconnection.

4. Suction the airway (consider simultaneous bag ventilation) to verify patency and clear mucous plugs.
5. Consider increasing sedation or pharmacological paralysis if ventilator dysynchrony is present.
6. Consider pneumothorax/hemothorax.
    a. Review peak pressure trend if using volume ventilation.
    b. Review VT trend if using pressure control ventilation. V_T will decrease if significant pneumothorax develops and ΔP is not changed.
    c. Evaluate existing chest tubes for proper function.
    d. Needle decompress the chest and place a chest tube if there is suspicion of pneumothorax and concurrent hemodynamic compromise.
7. Consider recruitment maneuver and increasing PEEP to next level on titration table.
    a. Additional lung can often be recruited using sustained inflations of the lung.
    b. Classic recruitment maneuver consists of inflation to 30-40 cm H_2O for 30-40 seconds, which is difficult to do on transport ventilators.
    c. Recruitment maneuver can be performed with bag-valve manual ventilation.
        i. Set PEEP valve on bag-valve unit to 15-20 cm H_2O.
        ii. Deliver five sequential breaths, each held for 5-8 seconds.
        iii. Watch blood pressure closely and terminate maneuver immediately if hypotension develops.
        iv. Clamp endotracheal tube while switching between ventilator and bag. Exposure to atmospheric pressure will quickly result in lung derecruitment, hypoxemia and increased ventilator induced lung injury.

Monitoring Oxygen Utilization

1. When using PTLOX, periodically check amount of oxygen consumed.
2. Oxygen consumption may vary between ventilators, even with the same settings.
3. Leaks in system may cause excessive oxygen consumption.
4. Comparing actual to predicted oxygen consumption will allow early detection of excess utilization that may necessitate troubleshooting, changes in management or diverting aircraft in extreme cases.

Appendix A: Oxygen Requirements

Oxygen Consumption Tables for LTV 1000 Ventilator

Liters of Gaseous Oxygen Consumed Per Hour

FiO2 \ Minute Ventilation	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.3	96	103	109	116	123	130	137	144	150	157	164	171	178	185	191	198	205
0.4	202	216	231	245	260	274	289	303	317	332	346	361	375	390	404	418	433
0.5	308	330	352	374	396	418	441	463	485	507	529	551	573	595	617	639	661
0.6	415	444	474	504	533	563	592	622	652	681	711	741	770	800	829	859	889
0.7	521	558	595	633	670	707	744	782	819	856	893	930	968	1005	1042	1079	1116
0.8	627	672	717	762	807	851	896	941	986	1031	1075	1120	1165	1210	1255	1299	1344
0.9	734	786	838	891	943	996	1048	1101	1153	1205	1258	1310	1363	1415	1467	1520	1572
1	840	900	960	1020	1080	1140	1200	1260	1320	1380	1440	1500	1560	1620	1680	1740	1800

Find the correct minute ventilation column then go down to the correct FiO2 row. The number where these intersect is the liters of gaseous oxygen consumed per hour. There is no safety factor in this calculation. The amount of safety factor needed should be determined by the team on a case-by-case basis.

Liters of Liquid Oxygen Consumed Per Hour

FiO2 \ Minute Ventilation	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.3	0.12	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.21	0.22	0.23	0.24	0.25	0.26
0.4	0.25	0.27	0.29	0.31	0.32	0.34	0.36	0.38	0.40	0.41	0.43	0.45	0.47	0.49	0.51	0.52	0.54
0.5	0.39	0.41	0.44	0.47	0.50	0.52	0.55	0.58	0.61	0.63	0.66	0.69	0.72	0.74	0.77	0.80	0.83
0.6	0.52	0.56	0.59	0.63	0.67	0.70	0.74	0.78	0.81	0.85	0.89	0.93	0.96	1.00	1.04	1.07	1.11
0.7	0.65	0.70	0.74	0.79	0.84	0.88	0.93	0.98	1.02	1.07	1.12	1.16	1.21	1.26	1.30	1.35	1.40
0.8	0.78	0.84	0.90	0.95	1.01	1.06	1.12	1.18	1.23	1.29	1.34	1.40	1.46	1.51	1.57	1.62	1.68
0.9	0.92	0.98	1.05	1.11	1.18	1.24	1.31	1.38	1.44	1.51	1.57	1.64	1.70	1.77	1.83	1.90	1.97
1	1.05	1.13	1.20	1.28	1.35	1.43	1.50	1.58	1.65	1.73	1.80	1.88	1.95	2.03	2.10	2.18	2.25

Find the correct minute ventilation column then go down to the correct FiO2 row. The number where these intersect is the liters of liquid oxygen consumed per hour. 1 L liquid oxygen = 800 L gaseous oxygen. There is no safety factor in this calculation. The amount of safety factor needed should be determined by the team on a case-by-case basis.

Hours of Use Per Liter of Liquid Oxygen

FiO2 \ Minute Ventilation	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.3	8.36	7.80	7.31	6.88	6.50	6.16	5.85	5.57	5.32	5.09	4.88	4.68	4.50	4.33	4.18	4.04	3.90
0.4	3.96	3.70	3.46	3.26	3.08	2.92	2.77	2.64	2.52	2.41	2.31	2.22	2.13	2.05	1.98	1.91	1.85
0.5	2.59	2.42	2.27	2.14	2.02	1.91	1.82	1.73	1.65	1.58	1.51	1.45	1.40	1.35	1.30	1.25	1.21
0.6	1.93	1.80	1.69	1.59	1.50	1.42	1.35	1.29	1.23	1.17	1.13	1.08	1.04	1.00	0.96	0.93	0.90
0.7	1.54	1.43	1.34	1.26	1.19	1.13	1.07	1.02	0.98	0.93	0.90	0.86	0.83	0.80	0.77	0.74	0.72
0.8	1.28	1.19	1.12	1.05	0.99	0.94	0.89	0.85	0.81	0.78	0.74	0.71	0.69	0.66	0.64	0.62	0.60
0.9	1.09	1.02	0.95	0.90	0.85	0.80	0.76	0.73	0.69	0.66	0.64	0.61	0.59	0.57	0.55	0.53	0.51
1	0.95	0.89	0.83	0.78	0.74	0.70	0.67	0.63	0.61	0.58	0.56	0.53	0.51	0.49	0.48	0.46	0.44

Find the correct minute ventilation column then go down to the correct FiO2 row. The number where these intersect is the number of hours that a 1 L of liquid oxygen will operate the ventilator. 1 L liquid oxygen = 800 L gaseous oxygen. There is no safety factor in this calculation. The amount of safety factor needed should be determined by the team on a case-by-case basis.

Minutes of Use Per Full D Cylinder

FiO2 \ Minute Ventilation	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.3	171	159	149	140	133	126	119	114	109	104	99	96	92	88	85	82	80
0.4	81	75	71	67	63	60	57	54	51	49	47	45	43	42	40	39	38
0.5	53	49	46	44	41	39	37	35	34	32	31	30	28	27	26	26	25
0.6	39	37	34	32	31	29	28	26	25	24	23	22	21	20	20	19	18
0.7	31	29	27	26	24	23	22	21	20	19	18	18	17	16	16	15	15
0.8	26	24	23	21	20	19	18	17	17	16	15	15	14	13	13	13	12
0.9	22	21	19	18	17	16	16	15	14	14	13	12	12	12	11	11	10
1	19	18	17	16	15	14	14	13	12	12	11	11	10	10	10	9	9

Find the correct minute ventilation column then go down to the correct FiO2 row. The number where these intersect is the number of minutes that a full D cylinder will operate the ventilator. Assumes full D cylinder contains 1800 psi, is empty at 100 psi and tank factor 0.16. There is no safety factor in this calculation. The amount of safety factor needed should be determined by the team on a case-by-case basis.

Appendix B: Mechanical Ventilation in ARDS

**********Not applicable to patients with TBI**********

Volume Control Ventilation

1. Set the I:E ratio at 1:2 to 1:4. The 731 ventilator defaults to a 1:2.5 I:E Ratio.
2. Set PEEP and FiO2 according to ARDSNet ARMA Trial PEEP table to achieve SaO_2 92-96%.[1] Note that the LTV 1000 is limited to PEEP 20 and the 731 limited to PEEP 25.
3. Set tidal volume at 6 cc/Kg and note peak inspiratory pressure (PIP).[2] If necessary, decrease tidal volume by 1 cc/Kgas needed to keep peak inspiratory pressure ≤ 35 cm H_2O (preferably ≤ 30). Do not go below 4 cc/Kg. Use table below as reference for appropriate tidal volume.[3]
4. Adjust respiratory rate to achieve pH ≥ 7.34. The actual PCO_2 is not important, only the pH.

Pressure Control Ventilation

1. Set I time to achieve I:E ratio of 1:2 to 1:4.
2. Set PEEP and FiO2 according to ARDSNet ARMA Trial PEEP table to achieve SaO_2 92-96%.[1] Note that the LTV 1000 is limited to PEEP 20 and the 731 limited to PEEP 25.
3. Set inspiratory pressure to achieve a tidal volume of 6 cc/kg. If this value is > 30 cm H_2O, then decrease until it is ≤30 cm H_2O or until tidal volume is 4 cc/kg. Use table below as reference for appropriate tidal volume.[3]
4. Adjust respiratory rate to achieve pH ≥ 7.34. The actual PCO_2 is not important, only the pH.

Tidal Volumes for Ventilation of Patients with ARDS – ARDSNET ARMA Trial

Male Patients – cc's per Kg

Height				4	5	6	7	8	9	10
ft in	in	cm	Pre Wt (Kg)							
5'6"	66	168	64	255	320	385	445	510	575	640
5'8"	68	173	68	275	340	410	480	545	615	685
5'10"	70	178	73	290	365	440	510	585	655	730
6'	72	183	78	310	390	465	545	620	700	775
6'2"	74	188	82	330	410	495	575	660	740	820
6'4"	76	193	87	345	435	520	610	695	780	870
6'6"	78	198	91	365	455	550	640	730	825	915

Female Patients – cc's per Kg

Height				4	5	6	7	8	9	10
ft in	in	cm	Pre Wt (Kg)							
5'	60	152	46	180	230	275	320	365	410	455
5'2"	62	157	50	200	250	300	350	400	450	500
5'4"	64	163	55	220	275	330	385	440	490	545
5'6"	66	168	59	235	295	355	415	475	535	595
5'8"	68	173	64	255	320	385	445	510	575	640
5'10"	70	178	69	275	345	410	480	550	615	685
6'	72	183	73	290	365	440	510	585	660	730

PEEP Titration Table - ARDSNet ARMA Trial

PEEP	5	5	8	8	10	10	10	12	14	14	14	16	18	18	20	22	24
FiO2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7	0.7	0.8	0.9	0.9	0.9	1	1	1	1

<------Move across table to keep SaO_2 92 – 96 %------->

Patients falling in shaded area are not necessarily too sick for flight but risks and benefits should be considered as described in the CPG.

1. Increasing PEEP can decrease cardiac output and may cause significant hypotension in hypovolemic patients. Additional volume loading may be necessary to maintain hemodynamics.
2. This is a fairly accurate indicator of plateau pressure in our patient population. Plateau pressure is the correct parameter to follow but it cannot be easily measured with the Impact 731 ventilator.
3. Measuring the patient's "wingspan" should be used as an estimate of height. Sternum to fingertip multiplied x 2.
4. A pH of 7.2 may be an appropriate target if hemodynamics are relatively normal.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Mechanical Ventilation Basics

This CPG provides an overview of prehospital and interfacility mechanical ventilation of a patient for point of injury to en route care up to Role 2 levels of care in a standardized approach.

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01 Sep 2023 update: SAVeO2 oxygen parameters

Safety statement, Nov 2022

CAUTION: The Hamilton T1 as fielded by the Department of Defense DOES NOT support noninvasive ventilation (NIV). In environments where there is a risk of patients requiring NIV, a different ventilator should be fielded.

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BACKGROUND

Appropriate consideration must be taken when placing a patient on a mechanical ventilator. Ventilator management is resource intensive and demanding which might not make it appropriate for all tactical situations. It is not without risk. The benefits should outweigh the attributable cost and risk of managing the mechanically ventilated patient, especially within the austere/ battlefield setting. Pathology associated with failure to oxygenate and failure to ventilate will most often require definitive airway interventions and appropriate mechanical ventilator support. At times, it may only serve as a temporizing measure while seeking definitive critical care. Institution of mechanical ventilation must be guided by clinical suspicion of underlying pathophysiology and clear criteria. Definitive airway management and sedation are often required for effective mechanical ventilation. See JTS CPGs *Airway Management of Traumatic Injuries and Analgesia and Sedation Management during Prolonged Field Care*. The intent of this CPG is to provide the non-critical care trained/proficient medical personnel with guidance on basic ventilator management until the appropriate level of care can be reached physically or via telemedicine in the operational environment while supporting ventilation, oxygenation, and reduce labored breathing while ensuring patient comfort. Additional JTS CPGs with ventilatory support considerations are *Acute Respiratory Failure and Wartime Thoracic Injury*.

DEFINITIONS

MECHANICS/PHYSIOLOGY OF BREATHING

1. **Respiratory drive**: The normal respiratory rate is 12-20 bpm. Respiratory drive is controlled by the hydrogen ion concentration in the cerebrospinal fluid and modified by receptors throughout the body. Increased intracranial pressure, administration of opioids and other medications may cause a decreased respiratory drive causing ventilation insufficient to maintain an adequate level of oxygenation and clearance of carbon dioxide (CO_2).[1-3]

2. **Work of breathing:** Work of breathing is the mechanical work needed to maintain oxygenation and ventilation. Pain, acidosis, and hypermetabolic states will cause an increased work of breathing. This is not necessarily pathologic but may indicate that the patient has increased CO_2 production and that respiratory support may be needed. Tachypnea secondary to shock could lead to inspiratory muscle fatigue which could eventually require mechanical ventilator support. [1-3]

3. **Lung compliance**: The tendency for the lungs to recoil from an inflated state is a good conceptual representation of compliance. Lung compliance impacts all functions of the respiratory system. Changes in lung compliance may be caused by both intrinsic and extrinsic causes. Atelectasis or fluid/blood in the alveoli can cause an intrinsic decrease in lung compliance. Examples of extrinsic causes of decreased compliance include obesity, pregnancy, burns, and chest wall injury. A decrease in lung compliance from any cause can lead to hypoxemia and hypercapnia. Fentanyl may also cause chest wall rigidity, leading to poor lung compliance. [1-3]

4. **Tidal volume (TV or V_T):** Is the volume of air that is exchanged in one breath. Decreases in tidal volume can result from external pressure (i.e. Pneumothorax, hemothorax, tension pneumothorax) by effectively reducing lung volume. Dynamic hyperinflation also known as "breath stacking" is caused by the inability to completely exhale and can lead to "auto-positive end expiratory pressure (auto-PEEP)." This may be due to inadequate exhalation time, airflow obstruction, or both. This condition leads to decreasing tidal volumes and can cause hemodynamic compromise. [1-3]

5. **Oxygenation**: The successful binding of oxygen to hemoglobin at the cellular level in the alveoli,

drives SaO_2 (arterial oxygen saturation) and SpO_2 (oxygen saturation) values. Successful alveolar gas exchange enables efficient aerobic respiration at the cellular level in all perfused body tissues. [1-3]

6. **Diffusion/exchange**: The process where oxygen (O_2) is exchanged with CO_2 on red blood cells in the alveoli/pulmonary capillaries for transport to body tissues. Pathologic conditions such as pulmonary edema, pneumonia, and acute respiratory distress syndrome (ARDS) can impair diffusion of oxygen across the alveolar membrane leading to reduced oxygen saturation of hemoglobin. [1-3]

7. **Fraction of Inspired Oxygen (FIO_2):** Normal atmospheric air contains 21% oxygen or an FIO_2 of 0.21. By increasing the percentage of oxygen delivered to the patient (supplemental oxygen), you can potentially increase the arterial oxygen saturation and oxygen content of the bloodstream. [1-3]

8. **Dead Space:** Any part of the airway where gas exchange does not occur, pharynx, larynx, trachea, bronchi, and ventilator tubing are examples.

9. **Hypoxia**: A state of O_2 deficiency in the tissue significant enough to cause impairment of function. There are four types of hypoxia that exist that must be accounted for during ventilator support: [1-3]

    - **Hypoxic Hypoxia**: Occurs when there is not enough available O2 in the surrounding environment or when decreasing atmospheric pressure prevents diffusion of O2 from the lungs to the bloodstream. Most commonly occurs during unpressurized transport at high altitude (>10,000 ft). This is correctable with supplemental oxygen.
    - **Hypemic Hypoxia**: Reduction of the blood's oxygen carrying capacity due to inadequate red blood cells (RBCs) (e.g., hemorrhage, anemia) or impairment to RBCs, carbon monoxide ([CO] poisoning, etc.). Correction of the causal factor is required.
    - **Stagnant Hypoxia**: Occurs at the circulatory level. Blood's O2-carrying capacity is adequate but circulation is inadequate (e.g., high-gravitational (G) forces, heart failure, blood vessel occlusion). Correction of underlying causal factor is required.
    - **Histotoxic Hypoxia**: Results from an interference with the use of O2 by body tissues. Alcohol, narcotics, or a poison such as cyanide (blue) is inhaled (or can be ingested) and is delivered to the tissues by the blood where it poisons the tissues, preventing use of available O2. Correction of underlying causal factor is required to positively change. [1-3]

VENTILATION

1. **Minute ventilation (V_E):** Tidal volume multiplied by the respiratory rate (normal is 60cc/kg/min), usually expressed in liters. The body regulates carbon dioxide through changes in minute ventilation. Increases in carbon dioxide leads to increased respiratory rate and/or tidal volume and increased minute ventilation (amount of air exchanged during one minute of ventilation). [1-3]

2. **Peak Inspiratory Pressure (PIP):** The greatest pressure within the lungs during inspiration. Pressures above 35mmHg have been shown to cause pressure-related lung injury (barotrauma). Ideally, pressures should remain at 30 mmHg and below. Increased peak pressures are usually due to increases in resistance within the respiratory system (e.g., tension pneumothorax, inability for adequate exhalation, edema). [1-3]

3. **Arterial Blood Gas (ABG):** This is the gold standard for evaluating acid-base status, oxygenation, ventilation and adjusting ventilation settings. If a point of care blood gas analyzer is available, this will enable targeted ventilator settings. Knowing these values will greatly improve critical care guidance via telemedicine resources. Consider placement of an arterial cannula for continuous

blood pressure and ABG sampling if it is appropriate for the operational setting and training level of the care provider.

Normal ABG values:

- pH (7.35-7.45)
- PaO2 (75-100 mmHg)
- $PaCO_2$ (35-45 mmHg)
- HCO3 (22-26 meq/L)
- Base excess/deficit (-4 to +2)
- SaO2 (90-96%)[4]

ABG DEFINITIONS

1. **pH:** Measure of hydrogen ion concentration (i.e. acid-base status). Acidosis (low pH) leads to coagulopathic states in trauma patients as well as development of potentially fatal cardiac arrhythmias.
2. **PaO_2:** Measurement of dissolved oxygen in blood, also a measurement of adequacy of gas exchange at the cellular level.
3. **$PaCO_2$:** Measurement of dissolved carbon dioxide in blood, also a measurement of adequacy of gas exchange at the cellular level.
4. **HCO_3 :** Measurement of bicarbonate in the blood, serves as a buffer against acid.
5. **Base excess:** Gives indication of metabolic component of blood gas results, most likely will not change field ventilator management but can provide information for telemedicine consultation regarding adequacy of resuscitation.
6. **SaO_2** : Percentage of oxygen bound to hemoglobin in arterial blood, correlates closely with SpO_2 values.
7. **End Tidal CO_2 ($ETCO_2$):** Measurement of carbon dioxide on end tidal expiration. Normal values are 35mmHg-45mmHg. Exhaled gasses are analyzed by either vital signs monitor or portable $ETCO_2$ devices (e.g., EMMA) a quantitative capnograph or capnometer is the clinical standard of care with invasively ventilated patients.
8. **Plateau Pressure: (PPLAT):** The pressure applied to small airways and alveoli during positive-pressure mechanical ventilation. It is measured during an inspiratory pause on the mechanical ventilator. A mechanically ventilated patient with a plateau pressure greater than 35cm is at an increased risk for barotrauma.

VENTILATOR TERMS

1. **Volume-targeted modes:** Volume constant, inspiration terminates when preset V_T delivered. Peak airway pressure is variable and increases as needed to deliver prescribed V_T. This is generally represented by a constant flow waveform.
2. **Pressure-targeted modes:** Volume variable, terminates when airflow falls below threshold level. Peak airway pressure is fixed, determined by set pressure level. This is generally represented by a decelerating flow waveform.

3. **Tidal volume (V_T):** Is the volume of gas, exchanged during a breath and commonly expressed in milliliters. V_T is generally set between 4-8 ml/kg ideal body weight (IBW), to prevent lung over distension and barotrauma.
4. **Frequency (f):** Is the rate, per minute, of breathing (patient or ventilator). Known as respiratory rate (RR).
5. **Minute Ventilation (V_e):** Is the average volume of gas entering, or leaving, the lungs per minute, commonly expressed in liters per minute. The product of V_T and RR (respiratory rate). Normal V_e is 5 – 10 L/min.
6. **Inspiratory (I) and Expiratory (E) time and I:E ratio:** Is the time period over which the V_T is delivered. Setting a shorter inspiratory time (I) results in a faster inspiratory flow rate in volume cycled ventilation. Average adult inspiratory time is 0.7 to 1 second. I:E ratio is usually 1:2.
7. **Positive end-expiratory pressure (PEEP):** Is the amount of positive pressure that is maintained at end-expiration. It is expressed in centimeters of water (cmH_2O). The purpose of PEEP is to increase end-expiratory lung volume and reduce air-space closure at end-expiration. Normal physiologic PEEP is 5 cmH_2O.
8. **Pressure Support (PS):** Delivers flow at a set pressure, generally to overcome resistance of the airway and ventilator circuit. PS can also be used to support a spontaneously breathing patient, such as with Bi-PAP.
9. **Flow:** Is the velocity at which gas is delivered to the patient, expressed in liters per minute. When the flow rate is set higher, the speed of gas delivery is faster and inspiratory time is shorter.
10. **Peak Inspiratory Pressure (PIP):** Represents the total pressure that is required to deliver the V_T and depends upon various airway resistance, lung compliance, and chest wall factors. It is expressed in centimeters of water (cmH_2O).
11. **Sensitivity or trigger sensitivity:** Effort, or negative pressure, required by the patient to trigger a machine breath, commonly set so that minimal effort (-1 to -2 cmH_2O) is required to trigger a breath.[1,3]

VENTILATOR MODES

VOLUME-TARGETED MODES

1. **Volume-targeted modes**:
    a. **Volume Assist/Control (V-AC), Assist Control (AC) or Volume Control Ventilation (VCV)**: Delivers a preset number of mandatory breaths per minute. The patient can take their own breaths in addition to mandatory breaths, with each spontaneous breath receiving the full preset tidal volume. Airway pressures can vary during delivery. [1-3]
    b. **Volume Synchronized Intermittent Mandatory Ventilation (V-SIMV)** combines mandatory breaths and supported breaths. The ventilator delivers a preset number of mandatory breaths per minute. Any breaths over the set rate will be supported with a fixed amount of pressure support. [1-3]

2. **Pressure-targeted modes:**

    a. **Pressure Support Ventilation (PSV)** supports every patient breath with a preset amount of pressure support. No mandatory breaths are given, so the patient must be spontaneously breathing.

    b. **Pressure Assist control (P-AC), or Pressure Control Ventilation (PCV)** delivers a set number of mandatory pressure controlled breaths, in which the patient receives a fixed pressure during a preset inspiratory time. Any breaths over the set rate will be pressure controlled with the same amount of pressure. The delivered tidal volume will be based on the amount of pressure applied, the lung compliance and airway resistance of the patient.

3. **Adaptive Support Ventilation (ASV):** (*Is only available on the Hamilton T1)* ASV provides intelligent ventilation mode that continuously adjusts respiratory rate, tidal volume, and inspiratory time depending on the patient's lung mechanics and effort. This is similar to "Auto-Flow" or other like settings on different brands of ventilators.

4. **Continuous Positive Airway Pressure (CPAP).**

5. **Pressure Regulated Volume Control (PRVC)** (may be Impact 731 only).

VENTILATOR ADJUSTABLE SETTINGS

1. **Tidal volume (V_T):** the volume of gas, exchanged during a breath and commonly expressed in milliliters. V_T is generally set between 4-8ml/kg IBW, to prevent lung over distension and barotrauma.[4-8]

2. **Ideal IBW:** the weight at which tidal volume is calculated against instead of using actual weight. This enables patients to be ventilated in a lung-protective strategy. A quick reference chart can be found in Appendix A. IBW can be calculated manually as follows:

    a. Male: {(Height in inches-60) x 2.2} +50 (e.g. 72in-60= 12; 12 x 2.2 = 26.4; 26.4 + 50 = IBW of 76.4 kg)

    b. Female: {(Height in inches-60) x 2.2} +45 (e.g. 65in-60= 5; 5 x 2.2 = 11; 11 + 45 = IBW of 56 kg)

1. **Minute Ventilation (V_E):** The average volume of gas entering, or leaving, the lungs per minute, commonly expressed in liters per minute. Also called minute volume. Minute ventilation is the product of V_T and RR (respiratory rate). Normal V_E is 5 – 10 L/min. [5-9]

2. **I:E Ratio:** See I:E definition. I:E might need to be adjusted for physiology that requires extended exhalation time. [5-9] For example: Asthma patient may require an I:E of 1:3, 1:4, or 1:5 to allow for more exhalation time.

3. **Flow Rate:** Is the velocity at which gas is delivered to the patient, expressed in liters per minute. When the flow rate is set higher, the speed of gas delivery is faster and inspiratory time is shorter. [5-9]

4. **Peak Inspiratory Pressure (PIP):** Represents the total pressure that is required to deliver the V_T and depends upon various airway resistance, lung compliance, and chest wall factors. It is expressed in centimeters of water (cm H_2O).

5. **Sensitivity or trigger sensitivity:** Is the effort, or negative pressure, required by the patient to trigger a machine breath, commonly set so that minimal effort (-1 to -2 cm H_2O) triggers a breath.[1,3] This is usually seen with assist modes of ventilator operation.

6. **Pressure alarms:** Pressure alarms ensure that providers are alerted to pressures that fall outside of

appropriate ranges and have potential to harm the patient via barotrauma (over-pressure) or under-ventilation (circuit disconnect or under-pressure). Pressures will be determined by placing the patient on the vent for ~1-2 minutes and determining intrinsic peak inspiratory pressure. (Labeled as PEAK on 754 Ventilator (top right); Labeled as peak on Hamilton T1 ventilator (top left); Labeled as PIP on ZOLL EMV+ (731) (right center). Standard alarm settings should be:

a. High pressure alarm: 10 cmH2O above peak airway pressure.

b. Low pressure alarm: 5 cmH2O below peak airway pressure.

ASSESSMENT

Determining the need for mechanical ventilation early is critical for the effective application of a mechanical ventilation device. Clinical suspicion is vital to adequately predict a patient who will progress to respiratory compromise. Respiratory compromise requiring ventilator support can be identified early in M-massive hemorrhage, A-airway, R-respiratory, C-circulation, and H-hypothermia (MARCH) assessment. Inability to adequately oxygenate, ventilate, or guard the airway are indications for mechanical ventilatory support. Though it is uncommon for a mechanical ventilator to be applied at point of injury, the treating provider can begin to take steps necessary to prepare for the application of a ventilator (i.e. supplemental O_2, positioning, airway interventions).

***NOTE**: Apneic patients with adequate circulation and an open airway require immediate mechanical ventilation (i.e.* bag valve mask [*BVM]).*

Though ABGs are the standard for managing patients with respiratory compromise, they are not often readily available in the operational environment. Utilization of pulse oximetry (SpO_2) and capnography/capnometry ($ETCO_2$) can provide a rapid assessment of a patient's respiratory status (devices to achieve both are readily available in medical logistics systems).

SpO_2 values < 90% are indicative of potential oxygenation issues; however, values can be unreliable due to poor perfusion and altitude.

$ETCO_2$ values >45mmHg are indicative of hypoventilation, especially in the absence of tachypnea. Values <35mmHg are indicative of hyperventilation and should be corrected in the least invasive manner. Mental preparation for mechanical respiratory support should be considered.

A high index of suspicion for sepsis or other metabolic acidosis should be maintained in patients with low $ETCO_2$ and hyperventilation.

The inability for a casualty to maintain appropriate SpO2 or $ETCO_2$ values through less invasive measures (airway adjuncts, supplemental O2, etc.) indicates the need for escalating support. For locations with point of care blood analyzers, inadequate blood gas values also indicate the need for respiratory support.

***WARNING**: Prior to the application of mechanical ventilation and/or initiation of invasive airway devices (e.g., Endotracheal Tube (ETT), extraglottic airways), patients must receive adequate sedation (and paralysis as appropriate/required). Detailed guidelines for the initiation and maintenance of this sedation can be found in Analgesia and Sedation Management during Prolonged Field Care.*

APPLICATION OF MECHANICAL VENTILATION

If respiratory insufficiency amenable to respiratory support is identified during the assessment, the initiation of timely mechanical ventilation can improve casualty outcomes. This can be as simple as bag BVM support or as complex as a critical care transport ventilator (e.g. Hamilton T1 or Zoll EMV+).[10,16]

***CAUTION**: BVM respiratory support should be utilized as a temporary measure until mechanical ventilators can be applied. BVMs deliver irregular V_T and respiratory rates leading to inconsistent blood gas values.*
***NOTE**: Many patients may require increased sedation (and paralysis) for effective ventilation. Patients who are not properly sedated may cause issues with high pressure alarms as they breathe over the ventilator increasing their minute volume and intrathoracic pressures.*

INITIAL VENTILATOR SETTINGS

*Prior to first use, ensure ventilator (as applicable) has been pre-set to utilize parameters of the user's choice. Some ventilators may be preset to deliver an inspiration time (I-Time) instead of an I:E ratio. Failure to appropriately set up and save these ventilator settings may delay use of the ventilator.

1. **MODE**: AC or ASV (Hamilton T1 only)
2. **BPM/RRate**: 14BPM (10-30 range)
3. **TIDAL VOLUME**: 6ml/kg IBW (4-8ml/kg IBW range)

   Quick Reference (Male): (Detailed reference in Appendix A)

   - 66" = ~380cc [min: 255 / max: 510]
   - 69" = ~420cc [min: 283 / max: 566]
   - 72" = ~465cc [min: 310 / max: 621]
   - 75" = ~505cc [min: 338 / max: 676]
4. **FiO_2** : 21 - 100% (0.21-1.0) (low flow O_2 @ 3 LPM (liters per minute) = ~ 40% FiO_2 [flowrate on Saros oxygen concentrator])
5. **I:E Ratio**: 1:2
6. **PEEP**: 5 [Range 5-20 cmH20]
7. **Pressure Support**: 5 [Range 5-20 cmH20] Consider adding if the patient has airway edema or is being ventilated through a narrower diameter ETT.

INITIAL VENTILATOR SETTINGS

***NOTE:** Initial Ventilator settings are based on the patient's ideal body weight (IBW) and clinical condition. However, "basic" or standard starting points are necessary to begin treatment.*

1. Set the ventilator to Volume Assist/Control.
2. Set driving mechanics by type of ventilation. Tidal Volume at 4-6 mL/kg IBW (Average adult male is 500 mL).

3. Set rate to maintain an appropriate minute ventilation (V_E) of 4-8 L/min (V_T x Rate = V_E).
    a. For a MV of 6L and a V_T of 500, set the rate at 12.
    b. Continuous capnometry or capnography is the standard for invasive airway management and should be used to monitor ventilations and as a tool to increase or decrease frequency. $ETCO_2$ is especially important for monitoring TBI cases.
4. Set appropriate PEEP. Minimum of 5 cmH2O. Start there and titrate up as needed. In hypoxic patients, consider starting at 10 cmH2O.
5. Set Fi02. Depending on clinical condition the patient may need high Fi02. Start at 100% and titrate down using arterial blood gas and SpO2 data. Do not rely on Sp02 alone (if possible).[8]
6. Set Inspiratory: Expiratory Ratio (I:E) to 1:2 for most patients. Adjust to clinical conditions.
7. Oxygen requirements can be roughly calculated using Minute Ventilation x FiO_2 fraction to determine LPM of pure O2 required (e.g., V_E of 6 LPM @ 50% FiO_2 (0.5) = 3 LPM bottled or generated O2 required.)

***NOTE**: Full D cylinder is ~425 liters O2 at 2200psi (i.e. ~141minutes O2 @ 3 LPM requirement above). Calculations should account for discrepancies in tank fill, leaks, dead space, etc. (consider a planning factor of 1.5X calculated requirement).*

TROUBLESHOOTING

Airway compromise or lost airway: If at any time the patient begins to de-saturate or develop respiratory problems, immediately disconnect the ventilator, and manually ventilate the patient with BVM (with PEEP valve if available) and 100% O_2 while correcting issues utilizing the following **D.O.P.E.** algorithm.[8]

- **Displacement**: Verify that ETT is in place, patient not extubated/tube did not move during transfer. If the ETT has advanced – pull back to original length and attempt to bag; if tube has pulled farther out of trachea, DO NOT ATTEMPT TO ADVANCE the ETT without laryngoscopy or placement of bougie to verify tracheal placement. When advancing the bougie, feel for tracheal rings or stop/ resistance at the carina. If in doubt, remove the endotracheal tube and attempt BVM. If air movement is adequate, continue to bag ventilate the patient. Upon stabilization, consider alternative advanced airways (supraglottic airway or cricothyroidotomy).

  **If ETT moves freely, access for ETT bulb rupture via cuff manometer.[10]
- **Obstructions**: Assess for secretions in ETT. Suction if indicated.
- **Pressure**: Ensure that a tension pneumothorax / hemothorax has not developed (if the chest tube is in place, ensure it is properly suctioning, not kinked or clamped). If tension pneumo/hemothorax is suspected, perform immediate needle thoracentesis. Assess the need for escharotomy if circumferentially burned. Consider additional paralysis and sedation if patient does not tolerate ventilation.[8,10]
- **Equipment**: Ensure that ventilator did not fail; O2 tank not empty. If ventilator is operational, trace all tubes to the patient connection (airway tube, transducer line, exhalation line) ensuring patency and connections.[8]

- The utilization of concurrent waveform capnography may assist in determining the causative issue while working the D.O.P.E mnemonic.

High pressure alarms / Peak airway pressure alarms (Peak pressure >35 cm H2O): Correct problems causing increased airway resistance and decreased lung compliance, including pneumothorax or pulmonary edema. Check the ventilator to ensure the prescribed tidal volume is being delivered. Check for linked/crushed tubing.

Air leaks causing low pressure alarms / volume loss: Assess, correct air leaks in endotracheal tube, tracheostomy cuff, ventilator system; recheck ventilator to make sure prescribed tidal volume is delivered.[10]

Ventilator dyssynchrony: Is a clinical entity in which ventilator gas delivery and patient respiratory mechanics are not matched. Agitation and respiratory distress that develop in a patient on a mechanical ventilator who has previously appeared comfortable represents an important clinical circumstance that requires a thorough assessment and an organized approach. The patient should not always be automatically re-sedated but must instead be evaluated for several potentially life-threatening developments that can present in this fashion.[15]

Lung hyperinflation (air trapping) and auto-PEEP: Dynamic hyperinflation is associated with positive end-expiratory alveolar pressure, or auto-PEEP. The physiologic effects of air trapping include decreased cardiac preload because of diminished venous return into the chest. This can lead to hypotension and, if severe, to pulseless electrical activity and cardiac arrest. Dynamic hyperinflation can also lead to local alveolar over-distention and rupture. Prevent and manage lung hyperinflation by decreasing tidal volume, changing inspiratory and expiratory phase parameters, switching to another mode, and correcting physiological abnormalities that increase airway resistance.[12, 13] In an emergency, auto-PEEP from air trapping can be relieved by simply disconnecting the circuit from the endotracheal tube for 3-5 seconds, and then reconnecting.

CHANGES IN RESPIRATORY STATUS

1. Assess patient's prior interventions.
2. Assess the following patient's respiratory status:
   - Rate
   - Rhythm
   - Depth
   - Effort
3. Assess monitors:
   - Oxygenation (SpO_2)
   - $ETCO_2$ (with advanced airway)
   - Cardiac monitoring if available
4. Determine cause of ventilation issue and/or ventilator alarm using DOPE mnemonic.

Table 1. Trouble shooting – DOPE Algorithm

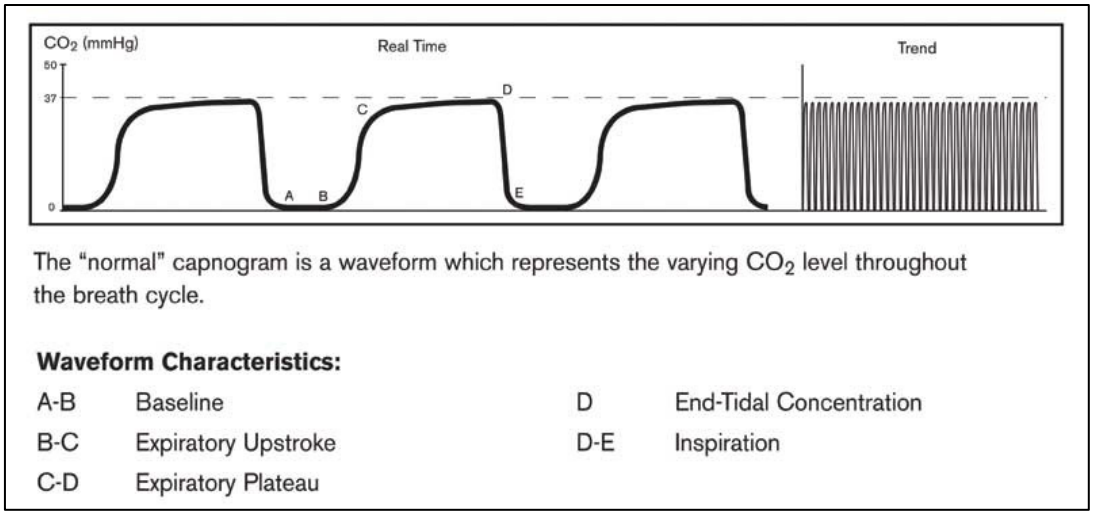
Alarm	DOPE	Possible Cause	Troubleshooting
High Pressure	D	Mainstem intubation	If the tube has advanced and unilateral ventilation is confirmed, retract the tube to proper depth using bougie technique to maintain placement.
High Pressure	D	Esophageal intubation	If the tube is advanced and unilateral ventilation is not present, rule out esophageal intubation. If breath sounds are present over abdomen, or gastric distention noted, remove the ET tube and secure airway by other means and place gastric tube for evacuation of gastric contents.
High Pressure	O	Obstruction of ET tube	Place patient on FiO_2 1.0 (100%) and prepare suction equipment. Suction airway using standard technique. If inhalation injury is suspected (burn, agent), saline may be used to facilitate suctioning.
High Pressure	O/E	Obstruction of ventilator circuit	Ensure circuit connections are attached and not kinked paying particular attention to connections and sharp bends.
High Pressure	P	Pulmonary circuit	Rule out/treat hemo/pneumothorax.
High Pressure	P	Pulmonary circuit	Consider Pulmonary Edema. Prolong Inspiratory time if appropriate (i.e. adjust from 1:3 to 1:2 to 1:1).
High Pressure	P	Pulmonary circuit	Consider airway swelling; may need to add or increase Pressure Support
High Pressure	P	Pulmonary circuit	Evaluate Tidal Volume. Consider lowering by 1cc/kg (min. 4cc/kg).
High Pressure	P	Patient arousal	Address analgesia/sedation needs.
High Pressure	P	Stacked breath/air trapping	Disconnect patient from the circuit and allow full exhale. Address cause (patient triggering, high rate, incomplete exhalation).
High Pressure	P	Chest tube malfunction	If hemo/pneumothorax are suspected, disconnect all attachments and troubleshoot chest tube and components.
High Pressure	P	Patient position	If laying supine, elevate head of bed (HOB) to reduce gravitational pressure on the chest.
High Pressure	E	Alarm setting	After ensuring patient optimization, adjust alarm settings.
Low Pressure	D	Extubation	If tube has been removed from the trachea, secure the airway using method within scope/skill of the provider.
Low Pressure	D	Esophageal intubation	If tube is advanced and unilateral ventilation is not present, rule out esophageal intubation. If breath sounds present over abdomen, or gastric distention noted, remove ET tube and secure airway by other means and place gastric tube for evacuation of gastric contents.
Low Pressure	E	ET tube balloon	Ensure ET Tube cuff is inflated (25-35 cmH2O). If the cuff will not maintain inflation, exchange ET tube using bougie technique.
Low Pressure	E	Ventilator disconnect/leak	Ensure all connections are attached securely to the appropriate point. Run bare hand along circuit to feel any air escaping during inhalation paying special attention to valves and connections.
Low SpO2	DOPE	Assess patient	For acute desaturation, place FiO_2 at 1.0 (100%). Check chest rise and fall, $ETCO_2$, SpO2 probe placement. Check all

Alarm	DOPE	Possible Cause	Troubleshooting
			conditions from high/low pressure chart to rule out other alarm failures.
Low SpO2	x	Increase in altitude	Increase FiO_2 to compensate for decrease in pressure.
Low SpO2	x	Patient deterioration	If desaturation is gradual and presumed to be caused by patient pathology, increase PEEP and FiO_2 in a stepwise fashion according to ARDSNet table.
Low SpO2	x	Patient deterioration	Attempt alveolar recruitment maneuvers. Inflation to 30 - 40 cm H_2O for 30 - 40 seconds (difficult with PMI). Recruitment maneuver can be performed with bag-valve manual ventilation. 1. Set PEEP valve on bag-valve unit to 15 - 20 cm H_2O. 2. Deliver five sequential breaths, each held for 5 - 8 seconds. 3. Watch blood pressure closely. Terminate if hypotension develops. 4. Clamp endotracheal tube while switching between ventilator and bag. 5. Immediately assess for tension pneumothorax, if applicable.
Low SpO2	E	O2 supply	Check O2 PSI and condition of hose/connections.)
High $ETCO_2$	E	Incorrect vent settings	V_E may be too low (Adjust V_T f/I:E for patients IWB).
High $ETCO_2$	x	Hypermetabolic state	Address pain, shivering, hyperthermia / infection.
High $ETCO_2$	x	Respiratory insufficiency	Increase rate (current $EtCO_2$ x current rate/40).V_E may be too high (Ensure proper V_T/f/I:E for patients IWB).
Low $ETCO_2$	E	Incorrect vent settings	V_E may be too high (Ensure proper V_T/f/I:E for patients IWB).
Low $ETCO_2$		Ventilator dyssynchrony	If on AC and patient is not properly sedated, the patient may be breathing over the ventilator settings, increasing their V_E. Consider sedation medications followed by paralytics, as needed.
Low $ETCO_2$	x	Low perfusion state (hypovolemia or sepsis)	CHECK PATIENT'S PULSE FOLLOWING RAPID DROP. Continue to resuscitate patient within scope and skill.
Low $ETCO_2$	x	Decrease in alveolar ventilation	Suction patient if suspected mucus/secretion plug. If associated with high pressure alarm, consider alveolar distention (air trapping/stacked breathing): remove patient from ventilator and allow full exhale.
Low $ETCO_2$	x	Respiratory compensation (metabolic acidosis)	DO NOT ATTEMPT TO NORMALIZE patient's breathing without ABG and expert consultation.

Source: USASAM, Enroute Care Branch Ventilator Guide[16]

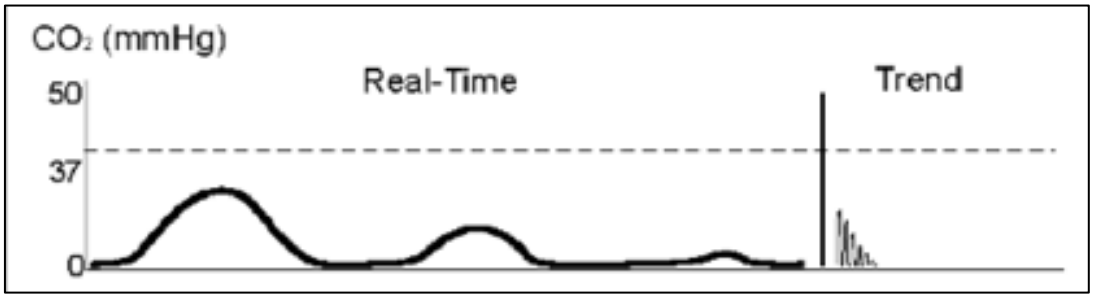
Figure 1. Recently published USAF EMS protocols

Normal Capnogram, Normal $ETCO_2$: 35-45 mmHg



Courtesy Respironics Inc. (2005). Capnography Reference Handbook.

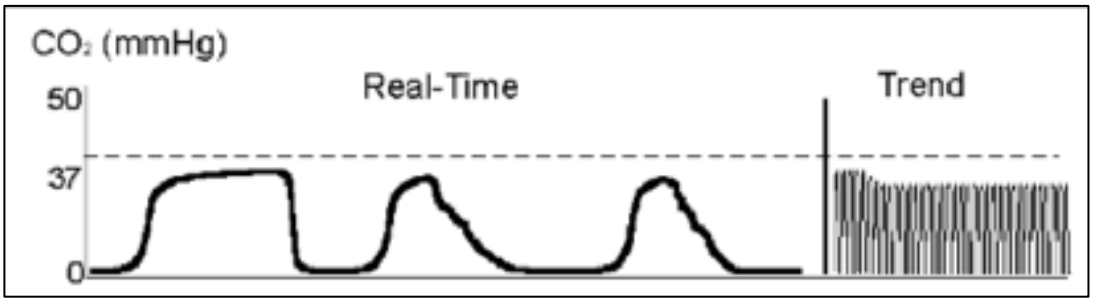
Endotracheal Tube in Esophagus



Possible causes:

- Missed intubation
- A normal capnogram is the best evidence that the ET tube is correctly positioned.
- With ET tube in the esophagus, little or no CO_2 is present.

Inadequate Seal around ET Tube

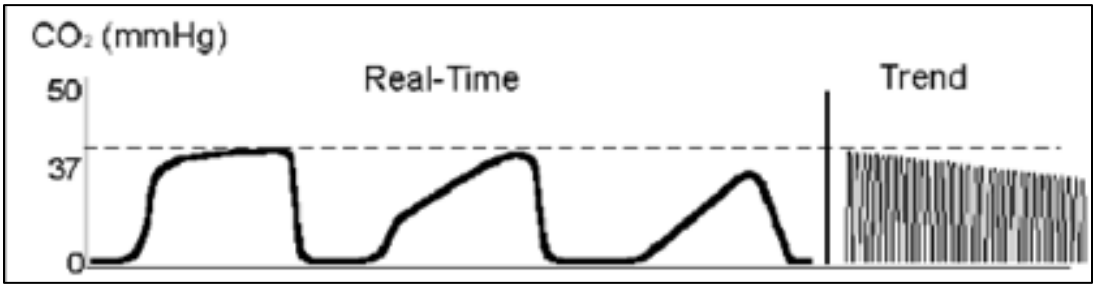


Possible causes:

- Leaky or deflated endotracheal or tracheostomy cuff

- Artificial airway is too small for the patient.

Obstruction in Airway or Breathing Circuit



Possible causes:

- Partially kinked or occluded artificial airway
- Presence of foreign body in the airway
- Obstruction in expiratory limb of breathing circuit
- Bronchospasm

Source: https://openairway.org/capnography

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with an advanced airway requiring mechanical ventilation during transport.

INTENT (EXPECTED OUTCOMES)

1. Initial tidal volume is based on ideal body weight, targeting 6cc/kg.
2. $EtCO_2$ is monitored when available, targeting a range between 35-45 mmHg.
3. Adjustments to respiratory rate, tidal volume, F_IO_2, and PEEP are based on clinical indicators (i.e. oxygen saturation, peak airway pressure, $EtCO_2$) and documented on DA 4700 (TACEVAC Patient Care Record).
4. All patients in the population of interest arrive with $PaCO_2$ 35-45mmHg.

PERFORMANCE/ADHERENCE MEASURES

Number and percentage of patients with an advanced airway that arrive with initial $PaCO_2$ 35-45mmHg.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: PREDICTED BODY WEIGHT AND TIDAL VOLUME

Predicted Body Weight and Tidal Volume (V_T)

Male PBW and Tidal Volume

Height		Predicted Body Weight	ml per kg of PBW (total V_T)				
Ft'In"	Inches		4.0 ml	5.0m l	6.0m l	7.0 ml	8.0 ml
4'0"	48	22.4	90	112	134	157	179
4'1"	49	24.7	99	124	148	173	198
4'2"	50	27	108	135	162	189	216
4'3"	51	29.3	117	147	176	205	234
4'4"	52	31.6	126	158	190	221	253
4'5"	53	33.9	136	170	203	237	271
4'6"	54	36.2	145	181	217	253	290
4'7"	55	38.5	154	193	231	270	308
4'8"	56	40.8	163	204	245	286	326
4'9"	57	43.1	172	216	259	302	345
4'10"	58	45.4	182	227	272	318	363
4'11"	59	47.7	191	239	286	334	382
5'0"	60	50	200	250	300	350	400
5'1"	61	52.3	209	262	314	366	418
5'2"	62	54.6	218	273	328	382	437
5'3"	63	56.9	228	285	341	398	455
5'4"	64	59.2	237	296	355	414	474
5'5"	65	61.5	246	308	369	431	492
5'6"	66	63.8	255	319	383	447	510
5'7"	67	66.1	264	331	397	463	529
5'8"	68	68.4	274	342	410	479	547
5'9"	69	70.7	283	354	424	495	566
5'10"	70	73	292	365	438	511	584
5'11"	71	75.3	301	377	452	527	602
6'0"	72	77.6	310	388	466	543	621
6'1"	73	79.9	320	400	479	559	639
6'2"	74	82.2	329	411	493	575	658
6'3"	75	84.5	338	423	507	592	676
6'4"	76	86.8	347	434	521	608	694
6'5"	77	89.1	356	446	535	624	713
6'6"	78	91.4	366	457	548	640	731
6'7"	79	93.7	375	469	562	656	750
6'8"	80	96	384	480	576	672	768
6'9"	81	98.3	393	492	590	688	786
6'10"	82	100.6	402	503	604	704	805
6'11"	83	102.9	412	515	617	720	823
7'0"	84	105.2	421	526	631	736	842

PBW Males = 50 + 2.3 [height (inches) - 60]

Female PBW and Tidal Volume

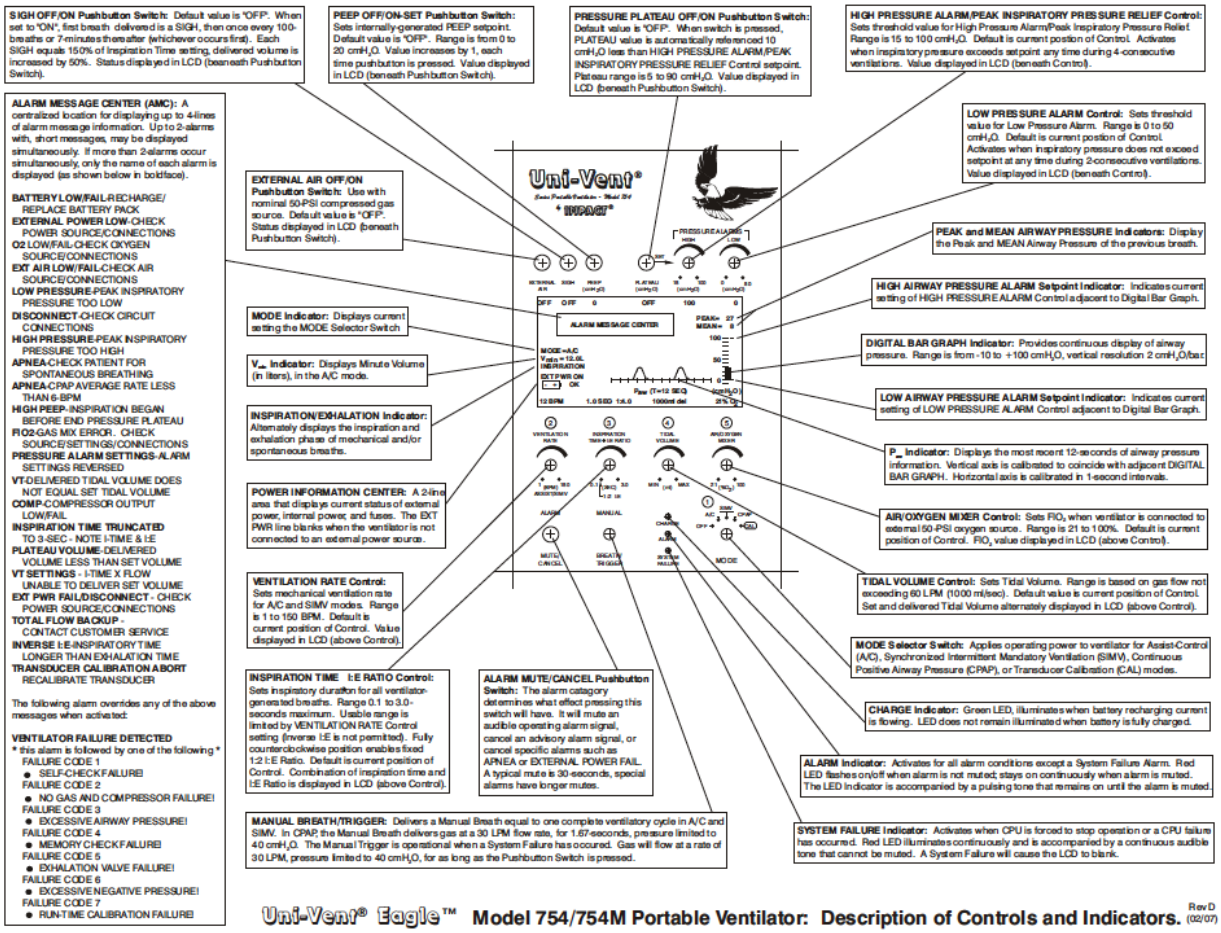
Height		Predicted Body Weight	ml per kg of PBW (total V_T)				
Ft'In"	Inches		4.0m l	5.0 ml	6.0 ml	7.0 ml	8.0 ml
4'0"	48	17.9	72	90	107	125	143
4'1"	49	20.2	81	101	121	141	162
4'2"	50	22.5	90	113	135	158	180
4'3"	51	24.8	99	124	149	174	198
4'4"	52	27.1	108	136	163	190	217
4'5"	53	29.4	118	147	176	206	235
4'6"	54	31.7	127	159	190	222	254
4'7"	55	34	136	170	204	238	272
4'8"	56	36.3	145	182	218	254	290
4'9"	57	38.6	154	193	232	270	309
4'10"	58	40.9	164	205	245	286	327
4'11"	59	43.2	173	216	259	302	346
5'0"	60	45.5	182	228	273	319	364
5'1"	61	47.8	191	239	287	335	382
5'2"	62	50.1	200	251	301	351	401
5'3"	63	52.4	210	262	314	367	419
5'4"	64	54.7	219	274	328	383	438
5'5"	65	57	228	285	342	399	456
5'6"	66	59.3	237	297	356	415	474
5'7"	67	61.6	246	308	370	431	493
5'8"	68	63.9	256	320	383	447	511
5'9"	69	66.2	265	331	397	463	530
5'10"	70	68.5	274	343	411	480	548
5'11"	71	70.8	283	354	425	496	566
6'0"	72	73.1	292	366	439	512	585
6'1"	73	75.4	302	377	452	528	603
6'2"	74	77.7	311	389	466	544	622
6'3"	75	80	320	400	480	560	640
6'4"	76	82.3	329	412	494	576	658
6'5"	77	84.6	338	423	508	592	677
6'6"	78	86.9	348	435	521	608	695
6'7"	79	89.2	357	446	535	624	714
6'8"	80	91.5	366	458	549	641	732
6'9"	81	93.8	375	469	563	657	750
6'10"	82	96.1	384	481	577	673	769
6'11"	83	98.4	394	492	590	689	787
7'0"	84	100.7	403	504	604	705	806

PBW Males = 45.5 + 2.3 [height (inches) - 60]

ARDSnet, NIH NHLBI ARDS Clinical Network Mechanical Ventilation V_T card

APPENDIX B: IMPACT 754

NOTE: Some Geographic Combatant Commands (GCC) have placed restrictions on use of Impact 754 Ventilators in U.S. Central Command. Check with the GCC Surgeon cell prior to utilization in theater.


SIGH OFF/ON Pushbutton Switch: Default value is "OFF". When set to "ON", first breath delivered is a SIGH, then once every 100-breaths or 7-minutes thereafter (whichever occurs first). Each SIGH equals 150% of Inspiration Time setting, delivered volume is increased by 50%. Status displayed in LCD (beneath Pushbutton Switch).
PEEP OFF/ON-SET Pushbutton Switch: Sets internally-generated PEEP setpoint. Default value is "OFF". Range is from 0 to 20 cmH2O. Value increases by 1, each time pushbutton is pressed. Value displayed in LCD (beneath Pushbutton Switch).
PRESSURE PLATEAU OFF/ON Pushbutton Switch: Default value is "OFF". When switch is pressed, PLATEAU value is automatically referenced 10 cmH2O less than HIGH PRESSURE ALARM/PEAK INSPIRATORY PRESSURE RELIEF Control setpoint. Plateau range is 5 to 90 cmH2O. Value displayed in LCD (beneath Pushbutton Switch).
HIGH PRESSURE ALARM/PEAK INSPIRATORY PRESSURE RELIEF Control: Sets threshold value for High Pressure Alarm/Peak Inspiratory Pressure Relief. Range is 15 to 100 cmH2O. Default is current position of Control. Activates when inspiratory pressure exceeds setpoint any time during 4-consecutive ventilations. Value displayed in LCD (beneath Control).
ALARM MESSAGE CENTER (AMC): A centralized location for displaying up to 4-lines of alarm message information. Up to 2-alarms with, short messages, may be displayed simultaneously. If more than 2-alarms occur simultaneously, only the name of each alarm is displayed (as shown below in boldface).
BATTERY LOW/FAIL-RECHARGE/ REPLACE BATTERY PACK
EXTERNAL POWER LOW-CHECK POWER SOURCE/CONNECTIONS
O2 LOW/FAIL-CHECK OXYGEN SOURCE/CONNECTIONS
EXT AIR LOW/FAIL-CHECK AIR SOURCE/CONNECTIONS
LOW PRESSURE-PEAK INSPIRATORY PRESSURE TOO LOW
DISCONNECT-CHECK CIRCUIT CONNECTIONS
HIGH PRESSURE-PEAK INSPIRATORY PRESSURE TOO HIGH
APNEA-CHECK PATIENT FOR SPONTANEOUS BREATHING
APNEA-CPAP AVERAGE RATE LESS THAN 6-BPM
HIGH PEEP-INSPIRATION BEGAN BEFORE END PRESSURE PLATEAU
FIO2-GAS MIX ERROR. CHECK SOURCE/SETTINGS/CONNECTIONS
PRESSURE ALARM SETTINGS-ALARM SETTINGS REVERSED
VT-DELIVERED TIDAL VOLUME DOES NOT EQUAL SET TIDAL VOLUME
COMP-COMPRESSOR OUTPUT LOW/FAIL
INSPIRATION TIME TRUNCATED TO 3-SEC - NOTE I-TIME & I:E
PLATEAU VOLUME-DELIVERED VOLUME LESS THAN SET VOLUME
VT SETTINGS - I-TIME X FLOW UNABLE TO DELIVER SET VOLUME
EXT PWR FAIL/DISCONNECT - CHECK POWER SOURCE/CONNECTIONS
TOTAL FLOW BACKUP - CONTACT CUSTOMER SERVICE
INVERSE I:E-INSPIRATORY TIME LONGER THAN EXHALATION TIME
TRANSDUCER CALIBRATION ABORT RECALIBRATE TRANSDUCER
The following alarm overrides any of the above messages when activated:
VENTILATOR FAILURE DETECTED
* this alarm is followed by one of the following *
FAILURE CODE 1
• SELF-CHECK FAILURE!
FAILURE CODE 2
• NO GAS AND COMPRESSOR FAILURE!
FAILURE CODE 3
• EXCESSIVE AIRWAY PRESSURE!
FAILURE CODE 4
• MEMORY CHECK FAILURE!
FAILURE CODE 5
• EXHALATION VALVE FAILURE!
FAILURE CODE 6
• EXCESSIVE NEGATIVE PRESSURE!
FAILURE CODE 7
• RUN-TIME CALIBRATION FAILURE!
EXTERNAL AIR OFF/ON Pushbutton Switch: Use with nominal 50-PSI compressed gas source. Default value is "OFF". Status displayed in LCD (beneath Pushbutton Switch).
MODE Indicator: Displays current setting the MODE Selector Switch
V.E Indicator: Displays Minute Volume (in liters), in the A/C mode.
INSPIRATION/EXHALATION Indicator: Alternately displays the inspiration and exhalation phase of mechanical and/or spontaneous breaths.
POWER INFORMATION CENTER: A 2-line area that displays current status of external power, internal power, and fuses. The EXT PWR line blanks when the ventilator is not connected to an external power source.
VENTILATION RATE Control: Sets mechanical ventilation rate for A/C and SIMV modes. Range is 1 to 150 BPM. Default is current position of Control. Value displayed in LCD (above Control).
INSPIRATION TIME I:E RATIO Control: Sets inspiratory duration for all ventilator-generated breaths. Range 0.1 to 3.0-seconds maximum. Usable range is limited by VENTILATION RATE Control setting (inverse I:E is not permitted). Fully counterclockwise position enables fixed 1:2 I:E Ratio. Default is current position of Control. Combination of inspiration time and I:E Ratio is displayed in LCD (above Control).
ALARM MUTE/CANCEL Pushbutton Switch: The alarm category determines what effect pressing this switch will have. It will mute an audible operating alarm signal, cancel an advisory alarm signal, or cancel specific alarms such as APNEA or EXTERNAL POWER FAIL. A typical mute is 30-seconds, special alarms have longer mutes.
MANUAL BREATH/TRIGGER: Delivers a Manual Breath equal to one complete ventilatory cycle in A/C and SIMV. In CPAP, the Manual Breath delivers gas at a 30 LPM flow rate, for 1.67-seconds, pressure limited to 40 cmH2O. The Manual Trigger is operational when a System Failure has occured. Gas will flow at a rate of 30 LPM, pressure limited to 40 cmH2O, for as long as the Pushbutton Switch is pressed.
LOW PRESSURE ALARM Control: Sets threshold value for Low Pressure Alarm. Range is 0 to 50 cmH2O. Default is current position of Control. Activates when inspiratory pressure does not exceed setpoint at any time during 2-consecutive ventilations. Value displayed in LCD (beneath Control).
PEAK and MEAN AIRWAY PRESSURE Indicators: Display the Peak and MEAN Airway Pressure of the previous breath.
HIGH AIRWAY PRESSURE ALARM Setpoint Indicator: Indicates current setting of HIGH PRESSURE ALARM Control adjacent to Digital Bar Graph.
DIGITAL BAR GRAPH Indicator: Provides continuous display of airway pressure. Range is from -10 to +100 cmH2O, vertical resolution 2 cmH2O/bar.
LOW AIRWAY PRESSURE ALARM Setpoint Indicator: Indicates current setting of LOW PRESSURE ALARM Control adjacent to Digital Bar Graph.
P.aw Indicator: Displays the most recent 12-seconds of airway pressure information. Vertical axis is calibrated to coincide with adjacent DIGITAL BAR GRAPH. Horizontal axis is calibrated in 1-second intervals.
AIR/OXYGEN MIXER Control: Sets FIO2 when ventilator is connected to external 50-PSI oxygen source. Range is 21 to 100%. Default is current position of Control. FIO2 value displayed in LCD (above Control).
TIDAL VOLUME Control: Sets Tidal Volume. Range is based on gas flow not exceeding 60 LPM (1000 ml/sec). Default value is current position of Control. Set and delivered Tidal Volume alternately displayed in LCD (above Control).
MODE Selector Switch: Applies operating power to ventilator for Assist-Control (A/C), Synchronized Intermittent Mandatory Ventilation (SIMV), Continuous Positive Airway Pressure (CPAP), or Transducer Calibration (CAL) modes.
CHARGE Indicator: Green LED, illuminates when battery recharging current is flowing. LED does not remain illuminated when battery is fully charged.
ALARM Indicator: Activates for all alarm conditions except a System Failure Alarm. Red LED flashes on/off when alarm is not muted; stays on continuously when alarm is muted. The LED Indicator is accompanied by a pulsing tone that remains on until the alarm is muted.
SYSTEM FAILURE Indicator: Activates when CPU is forced to stop operation or a CPU failure has occurred. Red LED illuminates continuously and is accompanied by a continuous audible tone that cannot be muted. A System Failure will cause the LCD to blank.
Uni-Vent®
IMPACT®
ALARM MESSAGE CENTER
MODE=A/C
EXT PWR ON
OK
12 BPM
1.0 SEC I:E 1:2
1000ml del
25 % O2
MODE
Uni-Vent® Eagle™ Model 754/754M Portable Ventilator: Description of Controls and Indicators. Rev D (02/07)

RULE OF 5S (KEEP IT SIMPLE VENT SETTINGS FOR ADULTS)

There are five numbered dials on the front of the Eagle/Impact Vent. Most settings can be set by remembering multiples of five. Do not hook up casualty to the breathing circuit until after the PEEP is set.

1. Dial 1 — Turn on to calibrate. You must calibrate the vent every time you turn it on. Turn the knob to the right. The LED display will show "Cal-Mode" and then "Cal-OK;" turn the knob to the left past Continuous Positive Airway Pressure (CPAP) and to Synchronized Intermittent Mandatory Ventilation (SIMV) or Assist Control.
2. Dial 2 — Ventilatory Rate — set at 10.
3. Dial 3 — I:E ratio of 1:2. Turn the knob all of the way to the left. This setting is generally satisfactory for all adults and pediatrics with trauma related requirements for mechanical ventilation. Medical problems like chronic obstructive pulmonary disease and asthma may require longer ratios, and this should be assessed after the initial settings have been set.
4. Dial 4 — Tidal Volume of 500 ml and adjust as needed. Tidal volume calculation is 4-8 ml/kg, therefore 6 ml/kg is recommended after the initial setting of 500.

5. Dial 5 — Air/oxygen mixer. For room air the knob will be all of the way to the left and for 100% 02 will be all of the way to the right.

IMPACT 754 VENTILATOR PRE-MISSION CHECKS AND TROUBLESHOOTING

Routine Care

Clean the unit and hose attachments with damp soapy cloth and wipe dry. Remove the inlet filter to check for dirt or debris. Check metal hose couplings for thread wear and debris.

Duty Inspection

1. Power Off Checks:
    a. Verify inspection is within the calibration date (6-month maintenance cycle).
    b. Check the air inlet is clear of obstructions and the filter is in place (Right side of vent).
    c. Verify the Gas ("OXYGEN IN" and "AIR IN") and Patient ("EXHALATION VALVE" and "TRANSDUCER") connections are clear and tight (Top of ventilator).
    d. Verify the "GAS OUT" clear leaf valve is installed and seated (reseat if loose, replace if missing).
    e. Inspect green high pressure oxygen hose for cracks, dry rot, threads, black O-ring (replace if damaged).

Connect the ventilator to a high-pressure oxygen source, turn on the oxygen tank and ensure no leaks are present. Turn off O2 when complete (conduct in environment conducive to hearing leaks).

2. Power On Checks
    a. Turn "MODE" (knob 1) to desired setting (AC, SIMV, CPAP). The ventilator will run a SELF-TEST upon set up (ventilator circuit should be disconnected). At this point, (CAL) is not required. If SELF-TEST results in a Calibration Failure, place (1) to CAL until CAL OK is displayed. If the calibration fails, the ventilator must be taken out of service.
    b. Check BATT OK
    c. Preset ventilator knobs to:
        - Rate (knob 2) 14
        - Inspiration Time (knob 3) 1:2
        - TIDAL VOLUME: 6ml/kg IBW (4-8ml/kg IBW range)

        *QUICK REFERENCE (Male): (Detailed quick reference in Appendix A)
            - 66" = ~380cc [min: 255 / max: 510]
            - 69" = ~420cc [min: 283 / max: 566]
            - 72" = ~465cc [min: 310 / max: 621]
            - 75" = ~505cc [min: 338 / max: 676]
        - FiO_2 (knob 5) 100%
        - Set HIGH pressure alarm to 35 cmH2O
        - Set LOW pressure to 15 cmH2O
    d. Turn OFF.
    e. Make sure the air inlet and gas out ports of the ventilator are protected and covered.

EMERGENCY PROCEDURES

These procedures should be practiced before being performed on live patients.

***NOTE**: Any known malfunction of the ventilator should be addressed prior to utilization. The following are not for routine use, but for emergencies when alternate ventilatory measures are not available and long term BVM is not practical.*

ALL CAUTIONS, WARNINGS, AND NOTIFICATIONS THAT CORRESPOND WITH THE 754 SCREEN WILL BE IN ALL CAPS

Inability to deliver high pressure O2 when needs exceed 21% FiO_2 (i.e. missing/unserviceable green high pressure hose).

Vent will alarm and show **O2 Low/Fail-Check Oxygen Source/Connections** on screen.

***NOTE**: First place the patient on BVM with supplemental oxygen. Second, check oxygen tank volume. Third, check the oxygen lines and connections.*

Alternative methods to increase delivered oxygen content:

1. Oxygen reservoir kit for low pressure supply (Part # 820-0097-15).
2. Oxygen reservoir fashioned from primary circuit and BVM.
   a. Connect short portion of main circuit tube to the BVM and to the air-inlet port.
   b. Connect BVM oxygen hose to the BVM and regulator.
   c. Set regulator to desired setting (~10LPM, but no lower than total minute volume).
3. Oxygen reservoir fashioned from second ventilator patient circuit.
   a. Cut/disconnect exhalation valve off of second ventilator circuit.
   b. Feed green transducer hose at least ¾ of the way down vent tubing (the goal is to get as close as possible to the air inlet port) and secure in place with tape (do not cover the end of the circuit).
   c. Connect the 90 degree/"L" shape fitting of the green transducer line to the oxygen regulator.
   d. Connect the opposite end of the vent tubing to the air inlet port.
   e. Set regulator on oxygen source to 10 LPM to deliver up to 99% F_IO_2.

Missing or damaged "Gas Out" leaf valve

Missing **Gas Out** leaf valve will trigger an alarm, give a **DISCONNECT-CHECK CIRCUIT CONNECTIONS**, no **PEAK** value will display, and little to no volume will be delivered to the patient.

1. Place the patient on BVM with supplemental oxygen.
2. Perform DOPE (Dislodgment, Obstruction, Pneumothorax, and Equipment) assessment.
3. Check **Gas Out** clear plastic leaf valve for installation and proper seating.
   - If the valve is folded, use a small object to gently unfold or push the valve back into place.
   - If missing, cover exterior **Gas Out** side ports with occlusive dressing (replacing **Gas Out** leaf valve is optimal, but is time consuming.)

WARNING: Occluding "Gas Out" side ports will enable the ventilator to provide full respirations, however, this will eliminate the anti-asphyxia function these ports provide. (Ventilator failure will result in increased resistance in spontaneous respiration) and strict surveillance must be kept on ventilator to ensure any further failure is caught immediately. Patients must immediately be transitioned to BVM in the event of any failure.

Compressor failure/alarms (may show CODE 2).

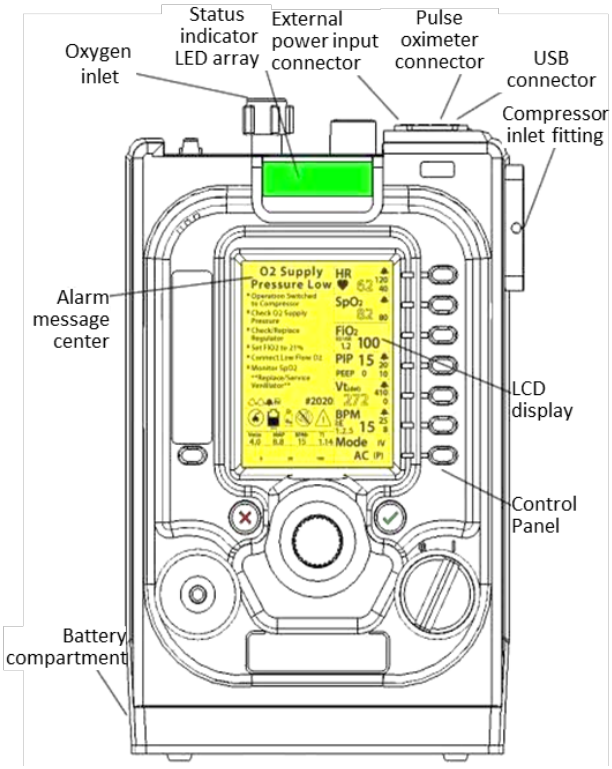
1. Place patient on BVM with supplemental O2.
2. Cycle ventilator to OFF.
3. Turn FiO_2 (knob 5) to 100%.
4. Cycle back on and to desired settings. MUST leave FiO_2 at 100%. PEEP will have to be reset when the vent is cycled on.

***NOTE**: This technique will transition the ventilator to using oxygen pressure instead of the compressor to gather drive ventilation and may hasten oxygen usage.*

Battery Failure

1. Place patient on BVM with supplemental O2.
2. Turn ventilator **OFF**.
3. Replace ventilator battery with battery from 326M suction apparatus (per the manufacturer, they are the exact same). The 326M battery is in the same location as the 754.
4. Resume normal operations. PEEP will have to be reset.

APPENDIX C: ZOLL EMV+ (731 SERIES)



1. Turn on the ventilator and ensure that the machine is functional and the battery is charged.
2. Attach the ventilator tubing and O2 tubing to the machine.
3. If the patient is a transfer on a vent, maintain ventilator settings from the medical treatment facility.
4. If the patient is "newly" on the ventilator, initial settings should include:
   a. MODE: AC
   b. BPM/RRate: 14BPM (10-30 range)
   c. TIDAL VOLUME: 6ml/kg IBW (4-8ml/kg IBW range)

   QUICK REFERENCE (Male): (Detailed quick reference in Appendix A)

   66" = ~380cc [min: 255 / max: 510]

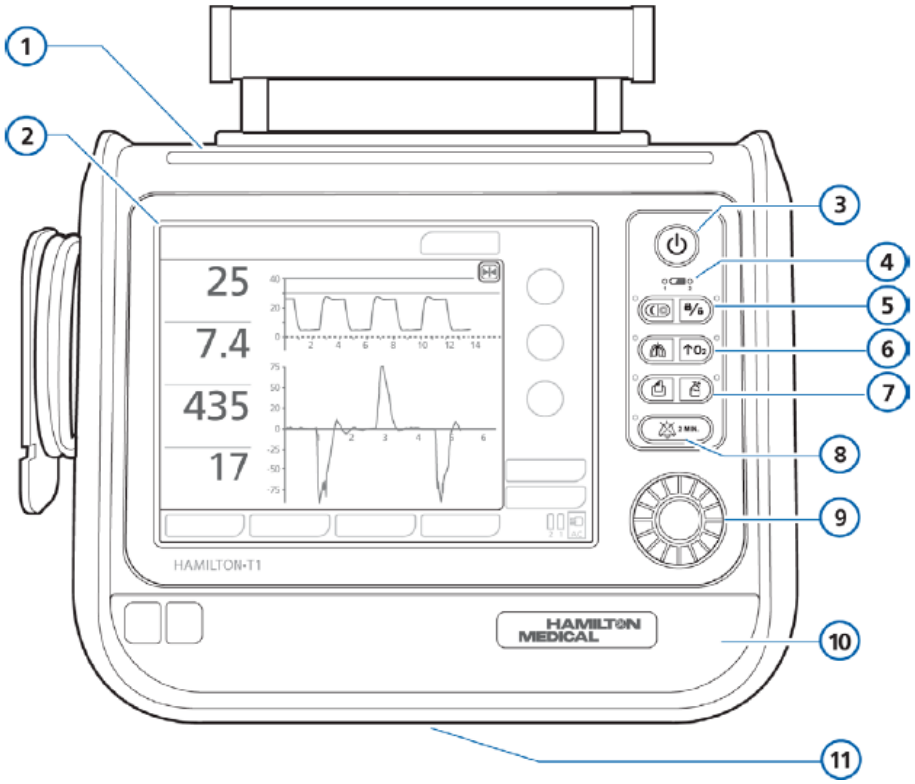
   69" = ~420cc [min: 283 / max: 566]

   72" = ~465cc [min: 310 / max: 621]

   75" = ~505cc [min: 338 / max: 676]

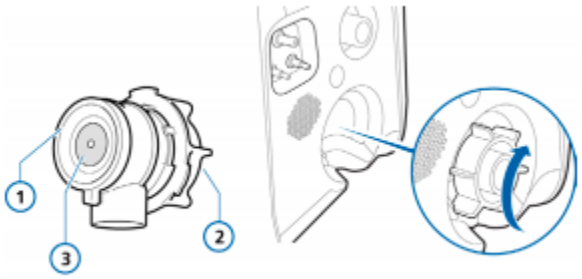
   d. FiO_2 : 21 - 100% (0.21-1.0) (low flow O2 @ 3 LPM = ~ 40% FiO_2 [flowrate on Saros oxygen concentrator])
   e. I:E Ratio: 1:2
   f. PEEP: 5 [Range 5-20]
5. Monitor waveform on the machine and visually inspect the patient to ensure no "breath stacking." If this occurs, a high-pressure alarm may sound. However, if breath stacking is suspected even in the absence of alarm – disconnect tubing and allow exhalation and decrease the I:E if possible from 1:2 to 1:4.

APPENDIX D: HAMILTON T1



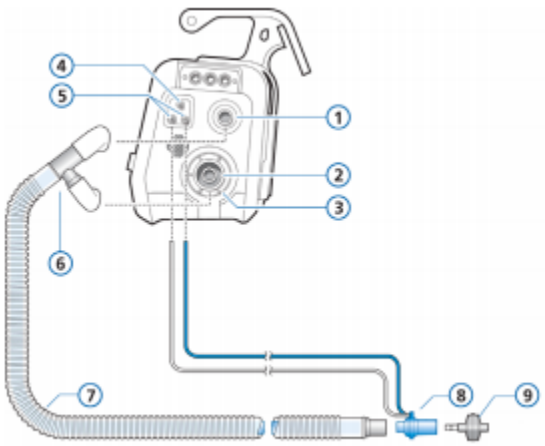
1 **Alarm lamp.** Red = high-priority alarm, yellow = medium- or low-priority alarm.
2 **Touch screen.** Provides access to measurements and controls.
3 **Power/Standby key.** Turns the ventilator on and off and accesses standby.
4 **Battery charge indicator.** Lit = battery is fully charged. Flashing = battery is charging.
5 **Day/Night key.** Switches between the Day and Night display brightness setting.
5 **Screen lock/unlock key.** Prevents inadvertent change of settings.
6 **Manual breath/inspiratory hold key.** Triggers a mandatory breath when pressed and released during exhalation. Triggers an inspiratory hold when held down during any breath phase. When active, the green indicator is lit.
6 **O2 enrichment key.** Delivers 100% oxygen for 2 min. Press the key a second time to cancel. Press **O2** key and disconnect patient to start a suctioning maneuver.
7 **Print screen key.** Save a JPG file of the current ventilator screen to a USB memory drive.
7 **Nebulizer on/off key.** Activates pneumatic nebulizer for 30 minutes or until pressed again during the inspiration phase if high-pressure oxygen (HPO) is connected.
8 **Alarm silence key.** Silences the main ventilator audible alarm for 2 min. Press the key a second time to cancel the alarm silence.
9 **Press-and-turn (P&T) knob.** Use to select and adjust ventilator settings.
10 **Front cover and battery.** The backup batteries are located inside the front cover.
11 **Underside of ventilator.** Expiratory valve bleed port. *Do not obstruct.*

1. Set up the ventilator.
    a. Install expiratory valve.



1 Expiratory valve membrane
2 Expiratory valve housing
3 Metal plate facing the ventilator

    b. Connect coaxial breathing circuit



1 To patient (inspiratory port)
2 From patient (expiratory port)
3 Adult/pediatric expiratory valve set
4 Nebulizer outlet
5 Flow sensor connectors
6 Limb connector
7 Coaxial inspiratory/expiratory limb
8 Flow sensor
9 HMEF

Connect the breathing circuit to the inspiratory and expiratory ports **(1, 2)** and the flow sensor tubes to the flow sensor connectors **(5)**.

    c. Enable Hamilton T1, EtC02, or Spo2 add ons if capable.
2. Perform pre-operational checks.
    a. Click **PreOp Checks** on main page.
    b. Conduct Tightness Test.
    c. Conduct Flow Sensor Test.

    Do not attach a patient to the ventilator without conducting both tests.
3. Select modes
    a. Input patient Gender and Height (this calculates all alarm values and “normal” ranges. ***Do not bypass this step***)
    b. Touch **Modes** to change ventilator mode.
    c. Select **ASV**.
4. Select settings
    a. Set Tidal Volume (4-8 ml/kg IBW) or Pressure Support (not to exceed 30 mmHg).

***NOTE**: This ventilator is "PEEP Compensated" which means when in Pressure Support mode if your Pressure Support is 20 and your PEEP is 10, your settings are actually 30 over 10. If you want 20 over 10, you need to see the Pressure Support at 10 and the PEEP at 10.*

This can get confusing, seek direction from medical control if necessary.

b. Set appropriate rate for age group.

c. Set Fi02 (21 to 100%).

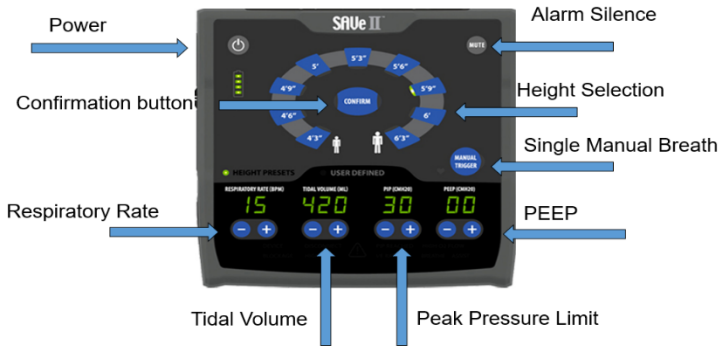
d. Set PEEP (5 to 20).

e. Adjust I:E Ratio as necessary.

5. Set Flow Trigger (0.5 to 5). Press the start ventilation button prior to connecting patient.
6. **Once the patient is on the ventilator, you may have to adjust alarm parameters**

APPENDIX E: SAVE II

NOTE: The SAVe II is designed for use in place of a Bag Valve Mask (BVM) in the pre-hospital environment. The intended use is to provide ventilator support or Positive Pressure Ventilation (PPV) to adults weighing >45kg (99lbs.).



1. Power on. The device will run through a self-test (all lights will illuminate, and will alarm for a moment).
2. Connect tubing: Tubing will only attach one way. Ensure any patient circuit is being attached on the light grey side of ports, as pictured above. Ensure all connections of the circuit are tight; loose connections may cause low pressure or disconnect alarm.
3. Select height and confirm (failure to select confirm will not change and or set appropriate settings). Any time a change is made, the CONFIRM button must be pressed. The device will default to a PEEP of 0; ensure adjustments are made IAW CPG or protocol.

4. Attach to airway device.

5. Confirm ventilations.

6. Adjust PEEP if needed by setting PEEP and hitting confirm.

***NOTE**: This device is intended for short term or transport use and is not intended to replace other ventilators available. Consider transitioning the patient to another ventilator (731, 754, or Hamilton T1) as soon as feasible.*

APPENDIX F: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of Department of Defense (DoD) policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion of off-label uses in CPGs is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion of off-label uses in CPGs is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, the DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

CLINICAL PRACTICE GUIDELINES FOR MILITARY WORKING DOGS

Military Working Dogs (MWDs) are critical assets for military police, special operations units, and others operating in today's combat environment. Expectations are that injured working dogs will receive the highest level of resuscitative care as far forward as possible, often in the absence of military veterinary personnel.

These guidelines are not a substitute for clinical judgments. (CPG ID: 16)

Photo credit: US Military Working Dog Teams National Monument, Lackland AFB, TX

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CHAPTER 1

Scope of Healthcare Provider Responsibilities

These clinical practice guidelines (CPGs) apply to deployed human healthcare providers (HCPs) in combat or austere areas of operations. Veterinary care is established at multiple locations throughout theater, and the veterinary health care team is the MWD's primary provider. However, HCPs are often the only medical personnel available to MWDs that are critically ill or injured. The reality is that HCPs will routinely manage working dogs in emergencies before they are ever seen by veterinary personnel.

Care by HCPs is limited to circumstances in which the dog is too unstable to transport to supporting veterinary facilities or medical evacuation is not possible due to weather or mission constraints; immediate care is necessary to preserve life, limb, or eyesight; and veterinary personnel are not available. HCPs should only perform medical or surgical procedures – within the scope of their training or experience – necessary to manage problems that immediately threaten life, limb, or eyesight, and to prepare the dog for evacuation to definitive veterinary care. Routine medical, dental, or surgical care is not to be provided by HCPs.

Emergent surgical management of injured MWDs may be necessary by HCPs to afford a chance at patient survival. This should be considered only if:

- The provider has the necessary advanced surgical training and experience.
- The provider feels there is a reasonable likelihood of success.
- The provider has the necessary support staff, facilities, and monitoring and intensive care facilities to manage the post-operative MWD without compromising human patient care.
- Emergent surgical management should be considered only in Role 2 or higher medical facilities and by trained surgical specialists with adequate staff. Direct communication with a US military veterinarian is essential before considering surgical management, and during and after surgery, to optimize outcome.

Considerations

Working dogs operated by allied military forces and DoD contractors may be presented for medical care by HCPs. Established agreements permit HCPs to provide necessary emergency care, just as if these dogs were MWDs.

The overarching goal when managing injured dogs is return to normal function and duty (RTD). Within reason, however, consider the adoption potential for dogs. Adoption of MWDs no longer fit for duty is authorized. Many MWDs with career-ending injuries have been successfully managed and ultimately adopted, some suffering these injuries while deployed. Consider emergency care, even if RTD is not likely but adoption is possible. HCPs should be reasonable, however, when considering the extent to which resources are allocated; dogs with multiple limb amputations or severe brain injury, for example, are not adoptable.

Information concerning MWDs (e.g., unit of assignment, operating location, illness or injury data, functional status) should be considered confidential and treated as such.

General Handling and Management of MWDs

MWDs are unpredictable and potentially dangerous animals, especially when ill, injured, or stressed, and especially when not under the control of a trained handler.

The dog handler is the best person to control the MWD; they have the most accurate information about past medical problems and the current situation, and they have first aid training and can assist in care. The MWD unit is responsible for providing a handler at all times.

Safety of HCPs and bystanders is paramount:

- Never examine a MWD without a handler present. Remove MWDs from areas where handlers are being treated; instances have occurred when MWDs aggressed on HCPs that the dog felt were threatening the handler.
- MWDs should be muzzled whenever being handled, unless medical issues prevent muzzling. Standard muzzles issued to handlers are ideal; however, roll gauze can be used for temporary control, looped tightly around the muzzle twice, and tied behind the head. Remove the muzzle when not actively handling the dog, if the dog is sedated or anesthetized, if the dog is having breathing difficulty, or if temperature extremes prevent cooling by panting.
- MWDs must be controlled and supervised at all times, especially if sedated or anesthetized. A handler must be immediately available 24 hours a day when MWDs are in a facility.
- MWDs must never be transported without a handler. If available, portable kennels are the best means of transport for stable MWDs. If a portable kennel is not available, MWDs transported in aircraft should be muzzled if their medical condition permits.

Evaluation and Treatment Tips

Note: Chapters 2-22 guide HCPs in management of specific scenarios involving life- or limb-threatening problems with MWDs.

Some supplies and equipment are unique to managing dogs, or differ from that used on people. Experience shows it is ideal to centrally locate these items in the area where injured dogs will be managed. Coordinate with supporting veterinary personnel for these items. Examples are dog hair clippers, dog muzzles, canine oxygen face masks, neonatal and pediatric blood pressure cuffs, and size 10mm and 11mm endotracheal and tracheostomy tubes. Durable medical equipment should be routinely disinfected for re-use, as is done after use on human patients.

MWDs with a catheter or bandage of any kind, or with wounds of any kind should be prevented from self-trauma and removal of devices. The simplest options for preventing self-trauma and device removal are either a loose-fitting muzzle (short-term use only) or application of a modified plastic bucket with the bottom cut off, secured around the neck using a collar (See Figures 21 and Figure 22).

Liberally clip hair at catheter sites, and around all wounds and over traumatized areas to reveal areas of "hidden" injury that might otherwise be missed.

Performance Improvement (PI) Monitoring

Intent (Expected Outcomes)

- HCPs manage MWDs safely in emergent situations to provide life-saving measures to resuscitate and stabilize injured dogs until evacuation is coordinated to a veterinary facility.
- HCPs do not perform medical or surgical procedures for non-emergent reasons or if veterinary personnel are available.
- HCPs promptly coordinate veterinary support and provide timely feedback in instances in which care is provided to MWDs.

Veterinary personnel will remain integrally involved in the decision chain for all MWD care issues. Current locations and contact information for theater veterinarians are found on the Veterinary Common Operating Picture or by contacting the TF MED/MED BDE TOC.

Performance/Adherence Measures

- Compliance review by supporting veterinary personnel of key data sources.
- Face-to-face discussions between supporting veterinary personnel and HCPs providing care.

Data Source

- Patient record generated by HCPs during care (Canine Resuscitation Record; See Chapter 22).
- Canine Tactical Combat Casualty Care card (See Chapter 22).

System Reporting and Frequency

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed biannually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Director, JTS Program Manager, and the JTS PI Division.

Responsibilities

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

The Director, DoD Military Working Dog Veterinary Service is responsible to update the MWD CPG in coordination with the JTTS and JTS Directors and is the final veterinary approval authority.

HCPs will:

- Notify veterinary personnel immediately upon notification of an inbound MWD or on the arrival of a MWD in any medical facility, especially in emergent situations.
- Complete medical care documentation as detailed in Chapter 22 any time emergent care is provided.

Normal Clinical Parameters for MWDs

Table 1. Normal Vital Signs at Rest.

NORMAL VITALS AT REST	
Temperature (rectal)	101° to 103° F
Heart/Pulse rate	60 - 80 bpm
Respiratory rate	16 - 30 bpm *(note that controlled panting is common in MWDs)*
Blood pressure	Systolic 120 mmHg, Diastolic 80mmHg, Mean 90-100 mmHg

Table 2. Complete Blood Cell Count Parameters.

BLOOD CELL COUNT PARAMETERS	
WBC	6 - 17 X 10^3/µL
RBC	5.5 - 8.5 X 10^6/µL
Hgb	12 - 18 g/dL
Hct	35 - 45%
MCV	60 - 77 fl
MCH	19.5 - 24.5 pg
MCHC	32 - 36 g/dL
Platelet count	200 - 900 X 10^3/µL

Table 3. Blood Chemistry Parameters.

***NOTE**: Results from serum chemistry analyzers calibrated for human serum may be unreliable or misleading based on methodology for **albumin** and **total calcium** concentrations.*

BLOOD CHEMISTRY PARAMETERS				
Albumin	2.5 - 4.4 g/dL		GGT	0 - 7 U/L
ALP	20 - 150 U/L		Glucose	60 - 110 mg/dL
ALT	10 - 118 U/L		HCO_3	17 - 25 mmol/L
Amylase	200 - 1200 U/L		Lactate	1.5 - 2.0 mmol/L
AST	14 - 45 U/L		pCO_2	24 - 38 mmHg
Bicarbonate	12 - 27 mmol/L		pH	7.35 - 7.45
BUN/SUN	7 - 25 mg/dL		pO_2	85 - 100 mmHg
Calcium (total)	8.6 - 11.8 mg/dL		Potassium	3.7 - 5.8 mmol/L
Chloride	105 - 111 mmol/L		Sodium	138 - 160 mmol/L
Creatine kinase	20 - 200 U/L		Total bilirubin	0.1 - 0.6 mg/dL
Creatinine	0.3 - 1.5 mg/dL		Total protein	5.4 - 8.2 g/dL

Unique Clinical Anatomy and Venous Access

Dogs differ anatomically and physiologically in several key areas in comparison to people. Knowledge of these differences will assist HCPs when managing MWDs.

Most MWDs are German shepherd dogs, Belgian Malinois, and Labrador retrievers, with an weight of 50-80# (23-36 kg). Dose drugs based on actual body weight whenever possible.

Canine blood can be tested using analyzers designed for people, with generally reliable results. Interpretation of results may be unreliable or misleading for albumin and total calcium, however, due to species-specific methodology differences. For all other parameters, if the results appear reasonable, trust them for decision-making.

Venous blood sampling and IV catheterization sites:

Use the cephalic or lateral saphenous veins for routine blood sampling, drug administration, and routine intravenous fluid therapy. Use the external jugular vein for long-term fluid therapy, large volume fluid delivery, and repeated blood sampling.

- Cephalic vein on the cranial (superior) aspect of the forearm (See Figures 1, 2, and 3).
- Lateral saphenous vein on the lateral aspect of the hind limb at the distal tibial area (See Figure 4).
- External jugular vein in the jugular furrow of the neck (See Figures 5-16). Standard human central venous catheter kits can be used; the Seldinger technique is most reliable.

Figure 1. Cephalic Vein Location on Superior Aspect of Forearm.

Figure 1 shows cephalic vein location on the cranial (superior) aspect of the forearm.

The vein is best punctured toward the elbow, as the accessory cephalic vein and cephalic vein join in a Y-shaped configuration more distally (toward the carpus).

Figure 2. Occluding the Vein.

Figure 2 shows proper technique for an assistant to occlude the vein, while extending the elbow joint. The assistant's thumb occludes the vein while rolling the vein outward at the elbow.

Figure 3. IV Catheter in Cephalic Vein of Forelimb.

Figure 3 shows properly placed and secured IV catheter in the cephalic vein of the forelimb of a MWD.

Figure 4. Lateral Saphenous Vein Location.

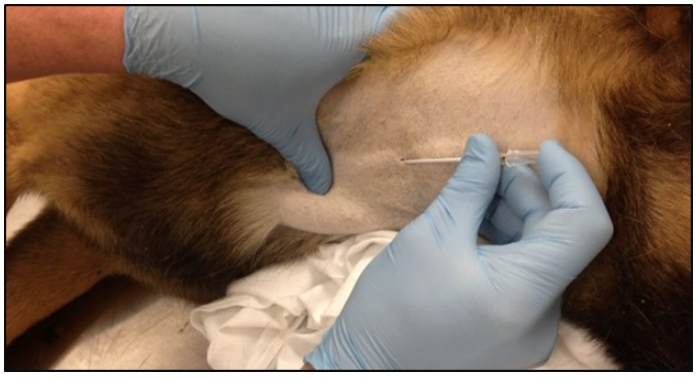
Figure 4 shows location of the lateral saphenous vein on the hind limb of a MWD, located on the lateral aspect of the distal tibial area, coursing caudodorsally from the hock (ankle) and over the gastrocnemius tendon.

Figures 5 – 16: External Jugular Vein Location and Central Venous Catheterization.

Figure 5 shows the right external jugular vein (dotted lines) located in the right jugular furrow. The vein is best punctured distal to the junction of the more-proximal tributaries (the optimal insertion site is noted by the red oval). Hair should be clipped and a sterile preparation should be performed.

Figure 6 shows a small skin nick (noted in the red oval) created over the intended catheter insertion site to facilitate penetration of the thick skin of the dog. This nick can be made with the tip of a #11 scalpel blade or the bevel of an 18-gauge needle.

Figure 7 shows insertion of a large bore catheter-over-needle through the skin nick, penetrating the skin and entering the external jugular vein. Note the use of the thumb of the opposite hand to occlude the vein. ***In this figure, and in Figures 8-12, sterile draping is removed to provide better visualization; perform catheterization using sterile technique.***



Jugular Vein Location & Central Venous Catheterization

Figure 8 shows full insertion of the over-the-needle catheter into the external jugular vein, after removal of the needle.

Figure 9 shows insertion of a Seldinger guide wire adapter into the hub of the catheter that has been placed into the external jugular vein.

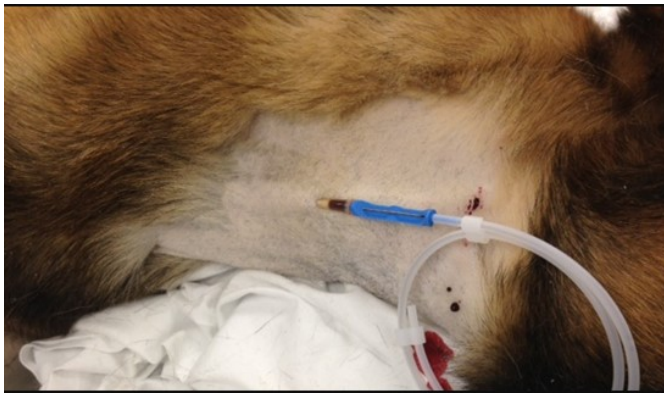


Figure 10 shows advancement of the Seldinger guide wire through the catheter and into the external jugular vein. Once the guidewire is advanced about two-thirds of its length into the vein, remove the catheter, leaving only the guidewire in place.

Figure 11 shows initial advancement of the multi-lumen central venous catheter over the guidewire. Use of a dilator (not shown) is often necessary before this step to enlarge the puncture site in the skin.

Figure 12 shows advancement of the catheter into the external jugular vein. Note extension of the guidewire from the proximal end of the catheter (red oval).

Figure 13 shows full insertion of the catheter into the external jugular vein, complete removal of the guidewire, and attachment of an injection port on the catheter hub.

Jugular Vein Location & Central Venous Catheterization

Figure 14 shows the optimal method to secure central venous catheters to the dog's skin using separate sutures at the wings of the catheter hub and circumferentially around the catheter base.

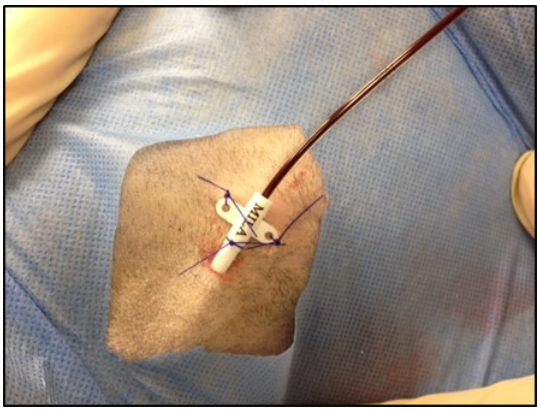


Figure 15 shows the optimal method to initially secure the central venous catheter using roll gauze or cast padding. Note that the catheter tubing (dotted line) is gently curved caudally and secured between snug layers of gauze/padding.

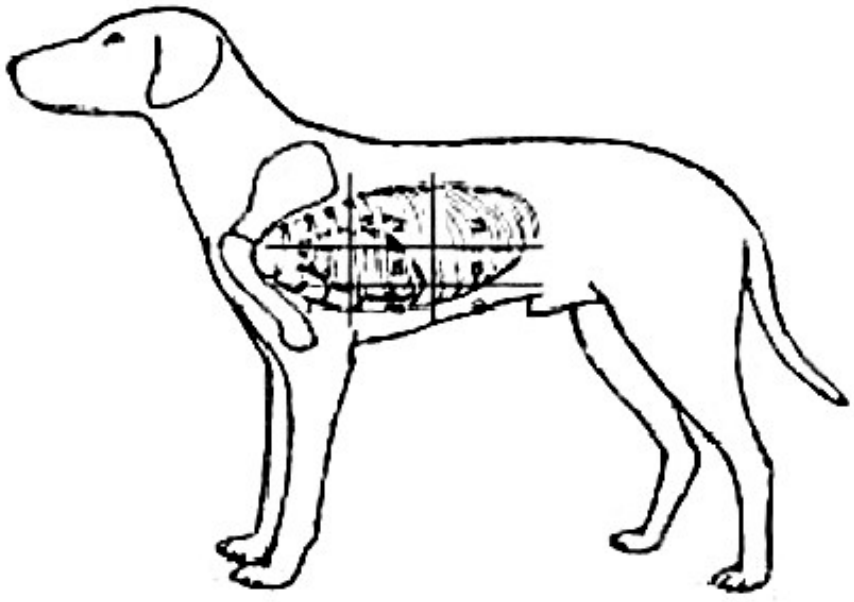
Figure 16 shows the optimal method to completely secure the central venous catheter using non-adherent bandage material placed over the underlying roll qauze/padding. Note: At least 2 fingers can be inserted beneath the bandage, ensuring the bandaging is not too tight.

Routine Cardiovascular Monitoring

- Heart sounds are best auscultated over the lower lateral thoracic wall between the 4th-5th intercostal spaces, typically where the elbow crosses the chest wall when the forelimb is pulled caudally (See Figure 17).

Figure 17. Heart Sounds Location.

Figure 17 shows optimal location for auscultation of the heart sounds and palpation of the heartbeat, in the 4th-6th intercostal space just above the sternum and just caudal to the elbow.



- The arterial pulse is best palpated at the femoral artery on the medial aspect of the proximal thigh in the inguinal area, or at the dorsal metatarsal artery on the dorsal aspect of the proximal hind paw. (Figure 18)
- Arterial blood pressure measurement is best measured non-invasively using the dorsal metatarsal artery, located on the dorsal aspect of the hind paw. Alternative sites are the lower forearm and tail base. Neonatal (size 4 or 5) or pediatric (size 6-8) human cuffs and an oscillometric technique work well. Use pediatric settings on the monitor.

Figure 18. Pulse location.

Figure 18 shows location for palpation of the femoral arterial pulse, in the inguinal region on the medial aspect of the proximal thigh.

Routine Cardiovascular Monitoring

- ECG adhesive electrodes should be taped to the pads of the paws of the left forelimb (black lead), right forelimb (white lead), and left hind limb (red lead), as shown in Figure 19. 3-lead electrocardiograms are the norm and are sufficient. Canine ECG complexes resemble human complexes, with minor variations in key electrocardiographic intervals.

Figure 19. Placement of ECG Electrode Pads.

Figure 19 shows a technique for placement of adhesive ECG electrodes.

- Pulse oximetry probes used for people (typically finger probes) are best placed on the tongue for optimal reliability (See Figure 20) in unconscious, sedated or anesthetized dogs. In conscious dogs, use the ear pinna, lip fold, or flank skin fold; while not optimal for oximetry, these alternate sites generally yield reliable results in most instances.

Figure 20. Placement of Human Pulse Oximeter Finger Probe on Tongue.

Figure 20 shows a technique for placement of standard human pulse oximeter finger probe on the tongue of an anesthetized dog.

Prevention of Self-trauma & Removal of Devices

Military working dogs will chew at catheters, bandages, and monitoring devices, and will excessively lick and chew at wounds to the point of causing foreign body ingestion and self-trauma. Use muzzles in the immediate period of initial monitoring and care to prevent this.

Tape catheters around the entire circumference of the limb, including the hub and catheter adapter port to adequately secure the catheter. The tape should be snug, but caution used to prevent excessive tightness that will result in distal edema.

For long-term management, a simple option is to fashion a preventive device. The bottom of a standard bucket is removed, 4-5 holes are drilled in the base of the bucket, and cable ties are used through these holes to secure the bucket to the dog's leather collar. The bucket-collar combination is then applied. (See Figures 21 and 22). Supporting veterinary personnel or MWD handlers should provide these.

Figure 21 shows the technique to make a bucket to prevent self-trauma by MWDs.

The bottom of a standard plastic bucket is removed, 4-5 holes are drilled near the base, and cable ties are used to secure the bucket to the dog's leather collar.

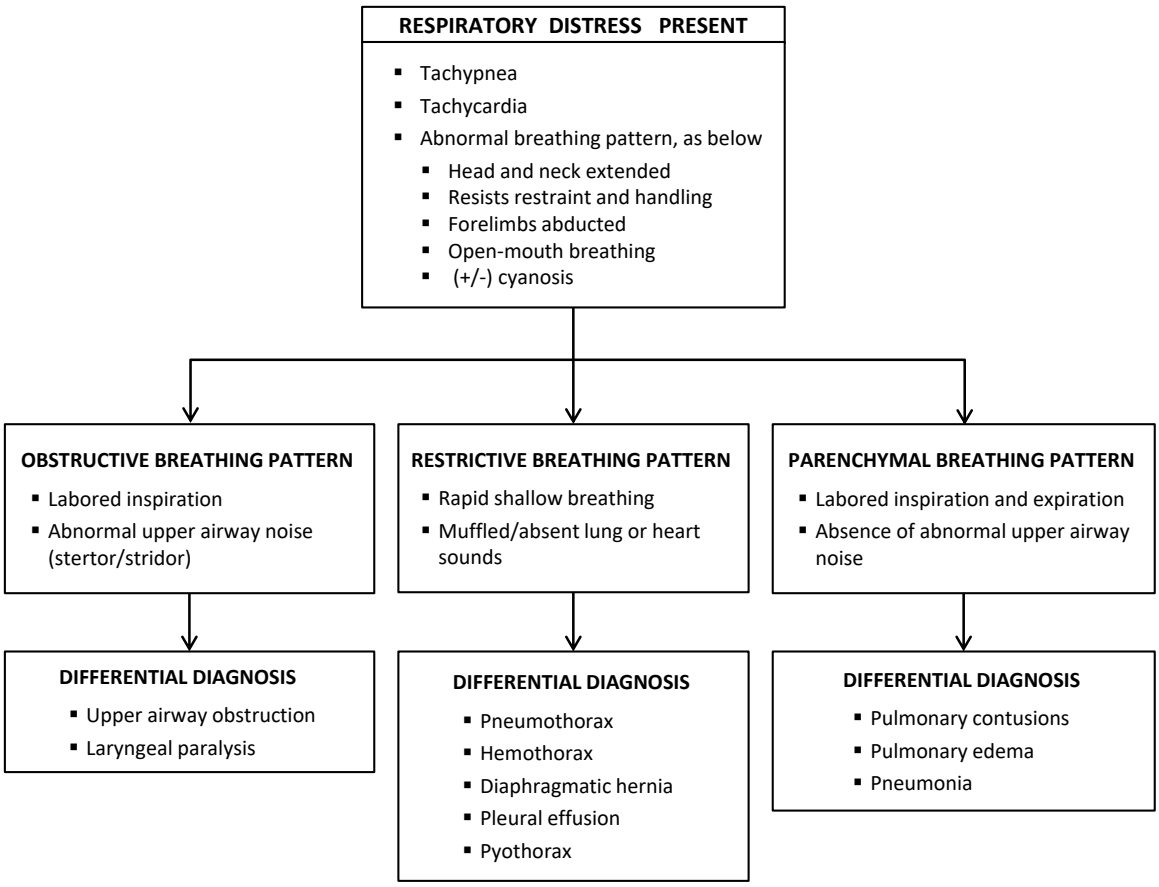
Figure 22 shows the bucket-collar device applied to a Military Working Dog.

Emergency Airway Management

Respiratory distress develops in deployed MWDs most commonly due to trauma. MWDs in respiratory distress are fighting to get oxygen: they are anxious, usually have obvious labored breathing, usually have their head and neck extended and elbows and upper legs held away from the chest, don't want to lie down, and fight restraint and handling. Cyanosis, if present, is a late finding. MWDs in respiratory distress typically have 1 of 3 characteristic breathing patterns that help localize the problem.

Figure 23 presents a clinical algorithm for differentiating the most likely cause of a patient's distress based on the pattern of breathing.

Figure 23. Clinical Algorithm for Differentiating Causes of Respiratory Arrest Based on Breathing Pattern.[1]



Oxygen Supplementation

Oxygen supplementation is essential. Provide 100% oxygen to all trauma patients and any patient that is showing signs of respiratory distress, until proven unnecessary.[4] Oxygen cages (makeshift or manufactured) and oxygen tents are impractical or not available in the typical HCP situation, so evacuate the MWD to the supporting veterinary facility if long-term oxygen therapy is necessary.

Conscious MWDs: Use face mask or "blow by" technique (hold end of oxygen tubing or circuit as close to nose and mouth as possible or attach to muzzle) using high flow rates of 10-15 L/min.[5] Use caution; ensure handler has control of the MWD at all times. Agitated, distressed or dyspneic MWDs will bite and can cause serious injury to the HCP or MWD handler. Figure 24 shows simple yet effective techniques to safely provide "blow-by" oxygen supplementation to muzzled MWDs. While not the ideal method, acceptable inspired oxygen concentrations of 40-70% are achieved with this technique,[5] which may be life-saving.

Unconscious MWDs: Use tracheal insufflation, orotracheal intubation, or tracheostomy (see Table 4, Table 5, and Table 6 for techniques).

Figure 24. Administration of Supplemental Oxygen.[4]
Figure 24 shows techniques for safe administration of supplemental oxygen to conscious or fractious muzzled dogs.

Upper Airway Obstruction with Obstructive Breathing Pattern

A patient with an obstructive breathing pattern typically has respiratory distress characterized by labored inspiration and abnormal upper airway noise such as stridor or stertor (See Figure 23).

- Common causes in trauma patients are facial and oropharyngeal swelling (jaw fractures, facial trauma), cervical injury (tracheal compression by hemorrhage in neck area, muscle edema), direct tracheal injury, severe snake and insect envenomation, bite wounds, smoke inhalation, electrocution, and foreign objects.
- Diagnosis is usually obvious based on history of trauma and presenting signs. For every trauma patient, carefully ensure the airway is open by physically opening the mouth, examining the oral cavity, and watching the patient breath. Palpate and examine the face, muzzle, nose, mouth, external laryngeal area, and trachea for deformities, traumatic wounds, or other abnormalities
- If the airway is not patent, immediately takes steps to open the airway (See Figure 25 next page).

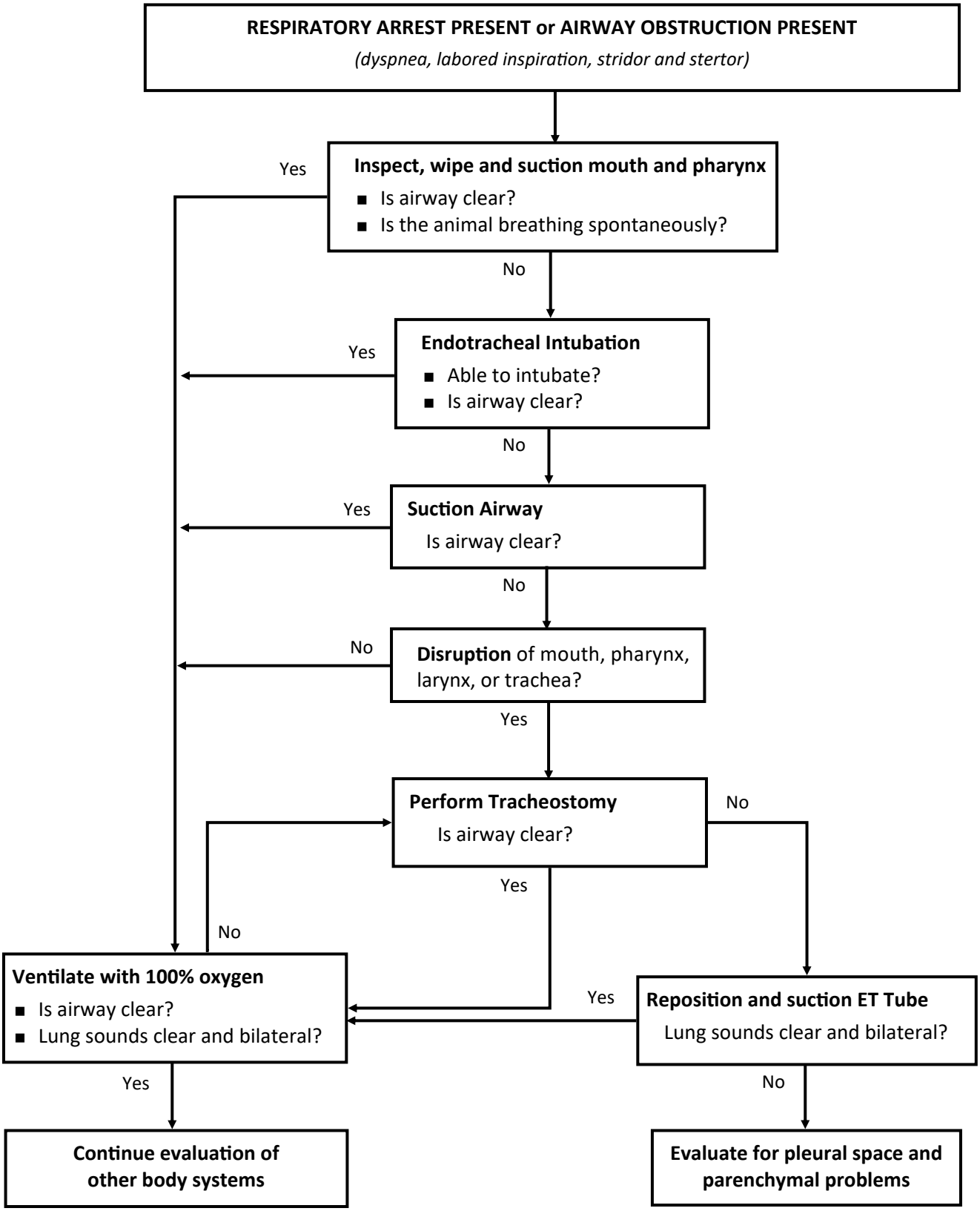
1. Provide oxygen therapy as above.
2. Bypass the obstruction until the patient is more stable:

    1) Attempt to remove the obstruction quickly by sweeping the mouth and pharyngeal area with a finger or gauze, suction the area, or use large forceps to remove objects that may be obstructing the passage.

    2) Do not attempt a Heimlich maneuver unless you know the object is smooth (e.g., ball); most trauma patients do not have a smooth foreign body obstruction, and the maneuver can cause significant patient distress and possibly further injury.

- If the obstruction cannot be removed in a few seconds, consider tracheal insufflation with oxygen for immediate oxygen delivery (See Table 4 for technique), and perform an emergency tracheostomy (See Table 5 for technique.
- Patient anxiety is frequently a compounding factor; tranquilize, sedate, or anesthetize if necessary.
- Management of patients with tracheostomy tubes requires 24-hour care and observation. Perform tracheal and pulmonary toilet as for human patients. Perform local wound care at least every 12 hours. Tube dislodgement is a potentially life-threatening complication that must be guarded against and monitored.

Figure 25. Airway Obstruction Management Algorithm for MWDs.



Tracheal Insufflation with Oxygen

TABLE 4. TRACHEAL INSUFFLATION WITH OXYGEN FOR MWD TECHNIQUE[6]
1. Clip hair and surgically prepare a 6 inch X 6 inch area of the ventral neck area just distal to the larynx.
2. For conscious MWDs, sedate and use 20 mg lidocaine locally.
3. Attach a 10 mL syringe to the hub of a 14 or 16 gauge, 6 inch, over-the-needle catheter.
4. Stabilize the trachea with one hand.
5. While holding the catheter-syringe apparatus at a 45° angle, direct the catheter through the skin and annular ring between the 3rd and 4th or 4th and 5th tracheal cartilages, directed ventrally down the trachea. Do not pass through the cricothyroid membrane in dogs.
6. Begin to slowly aspirate with the syringe as you pass the catheter through skin.
7. Once the tip of the needle is through the skin, aspiration of air signifies successful entry into the tracheal lumen.
8. Once the catheter is successfully introduced into the tracheal lumen, stabilize the needle to prevent any further advancement of the needle into the trachea.
9. Advance the catheter OFF the needle, directed down the trachea, until the hub of the catheter is in contact with the skin.
10. Remove the needle from the catheter.
11. Attach oxygen tubing to hub of catheter and provide high-flow oxygen (10-15 L/min).
12. Do not use this method for more than 30-45 minutes, as hypercapnia will develop and lung barotrauma may occur due to high airway pressures. Use tracheal insufflations as a “bridge” to more practical methods (e.g., orotracheal intubation, tracheostomy).

Emergency Tracheostomy

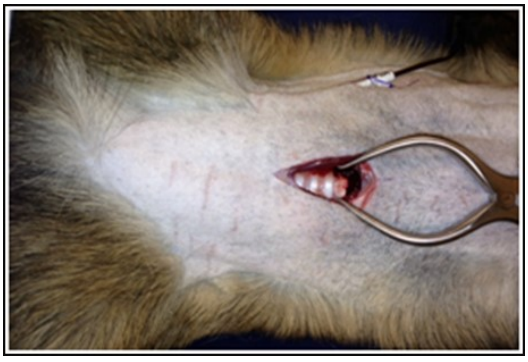
TABLE 5. EMERGENCY TRACHEOSTOMY OF MWD TECHNIQUE[6]

1. Position the animal in dorsal recumbency if unconscious, sedated, or anesthetized, extend the neck, and place a rolled towel or sandbag under the neck to force the trachea upwards. In conscious MWDs, position the MWD in sternal recumbency and extend the head upward to expose the ventral neck; sedate the dog and locally anesthetize the incision site with 20 mg lidocaine.

2. Clip the hair over the center of the ventral neck from the larynx to approximately the center of the neck, and prep the skin with surgical disinfectant.

3. Make a full-thickness, ventral midline skin incision 2-3 finger widths below the larynx (ideally over the 3rd to 5th cartilage rings) parallel with the long axis of the trachea. Do NOT make a transverse skin incision (perpendicular to the long axis of the trachea), as this increases the risk of injury to adjacent vessels and nerves.

4. Separate the muscle bellies overlying the trachea using sharp or blunt dissection. Place a Gelpi or Weitlaner retractor to spread the muscle bellies and allow visualization of the trachea.



5. Stabilize the trachea with the non-dominant hand.

TABLE 5. EMERGENCY TRACHEOSTOMY (CONTINUED)

6. Make a transverse incision completely through the annular ligament between the 3rd and 4th or 4th and 5th tracheal cartilages to create the tracheostomy. Do NOT extend the incision more than one-half (50%) of the diameter of the trachea. Do NOT incise at the cricothyroid ligament, as is done in people.

7. Using a cricothyroidotomy hook or stay sutures, retract the lower tracheal ring to open the tracheal lumen.

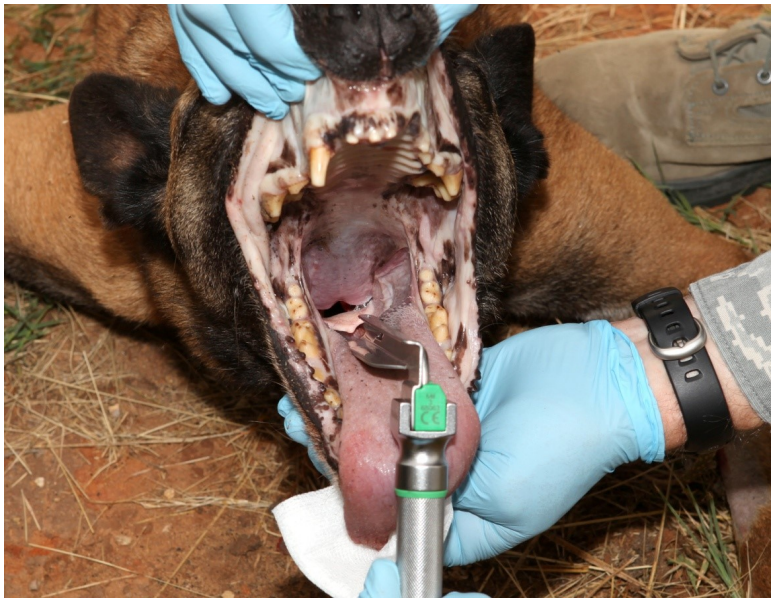
8. Insert a tracheostomy tube (ideal) or endotracheal tube through the incision and direct the distal opening down the trachea. Use the largest tube that will fit in the trachea; 7-11mm internal diameter tubes are typical.

9. Once the tube has been inserted, place long stay sutures around the cartilage rings above and below the tracheostomy. These allow rapid control of the airway should the tube become dislodged, and facilitates tube maintenance.

10. Secure the tracheostomy tube to the patient using umbilical tape, roll gauze, or similar material tied to the wings of the tube and passed around the neck and tied with a quick release knot. Do NOT suture the tube to the skin, as it cannot be removed rapidly if it obstructs.

11. Insert the inner cannula (if provided) in the tracheostomy tube (if used) and inflate the cuff of the tracheostomy tube.

Orotracheal Intubation

TABLE 6. OROTRACHEAL INTUBATION OF MWD TECHNIQUE[6]
1. Typical MWD needs a 9-11 mm internal diameter cuffed endotracheal tube.
2. Premeasure intended insertion length by placing the tube alongside the extended head and neck of the dog. Locate the larynx and position the cuff just below it. With the tube still lined up along side of the head and neck and the cuff positioned just below the larynx, apply a piece of tape to the tube opposite the lower canine teeth or incisors as a depth indicator when inserting the tube.
3. Cut and tie an 18 to 24 inch length of roll gauze to the end of the tube with the tape on it.
4. Lightly lubricate the cuffed end of the tube with sterile lubricant.
5. Place the MWD in sternal recumbency.
6. Have the handler lift and extend the dog's neck with one hand holding the upper jaw and the other hand holding the back of the head. Rolling the upper lips away improves visibility.
7. Grasp the animal's tongue with a dry 4X4 gauze sponge and gently pull the tongue out and down between the lower canine teeth.
8. Holding the laryngoscope in the other hand, place the tip of the blade on the base of the animal's tongue near the epiglottis and apply gentle downward pressure on the tip of the laryngoscope blade to visualize the opening to the trachea. 
9. Transfer the laryngoscope to the hand holding the animal's tongue.

10. With the free hand, using a slight rotating motion, guide the tube over the epiglottis, between the vocal cords, through the laryngeal opening, into to the trachea.

11. Advance the endotracheal tube into the trachea until the tape marker reaches the landmark.

12. Verify endotracheal tube placement.
    a. Palpate the dog's neck and feel for 1 tube. If 2 tubes are felt, the endotracheal tube is in the esophagus (1 "tube" is the trachea and the other is the endotracheal tube in the esophagus). Remove the tube and attempt intubation again if 2 tubes are felt.
    b. Place the base of the laryngoscope at a 90 degree angle next to the end of the endotracheal tube and look for fogging of the base caused by the animal exhaling air through the endotracheal tube. If fogging is noted, the tube is likely correctly placed.
    c. Attach a capnometer (if available) to the endotracheal tube and measure E_TCO_2. If E_TCO_2 is measured >10 mmHg, the tube is correctly positioned.

13. Inflate the cuff with the syringe until back pressure is noted in the syringe. Check for leaks and normal lung sounds during assisted ventilation.

14. Secure the tube into place by securing the attached roll gauze behind the canine teeth. Tie the gauze using a bow knot around the upper or lower jaw of the animal.

Emergency Airway Management References

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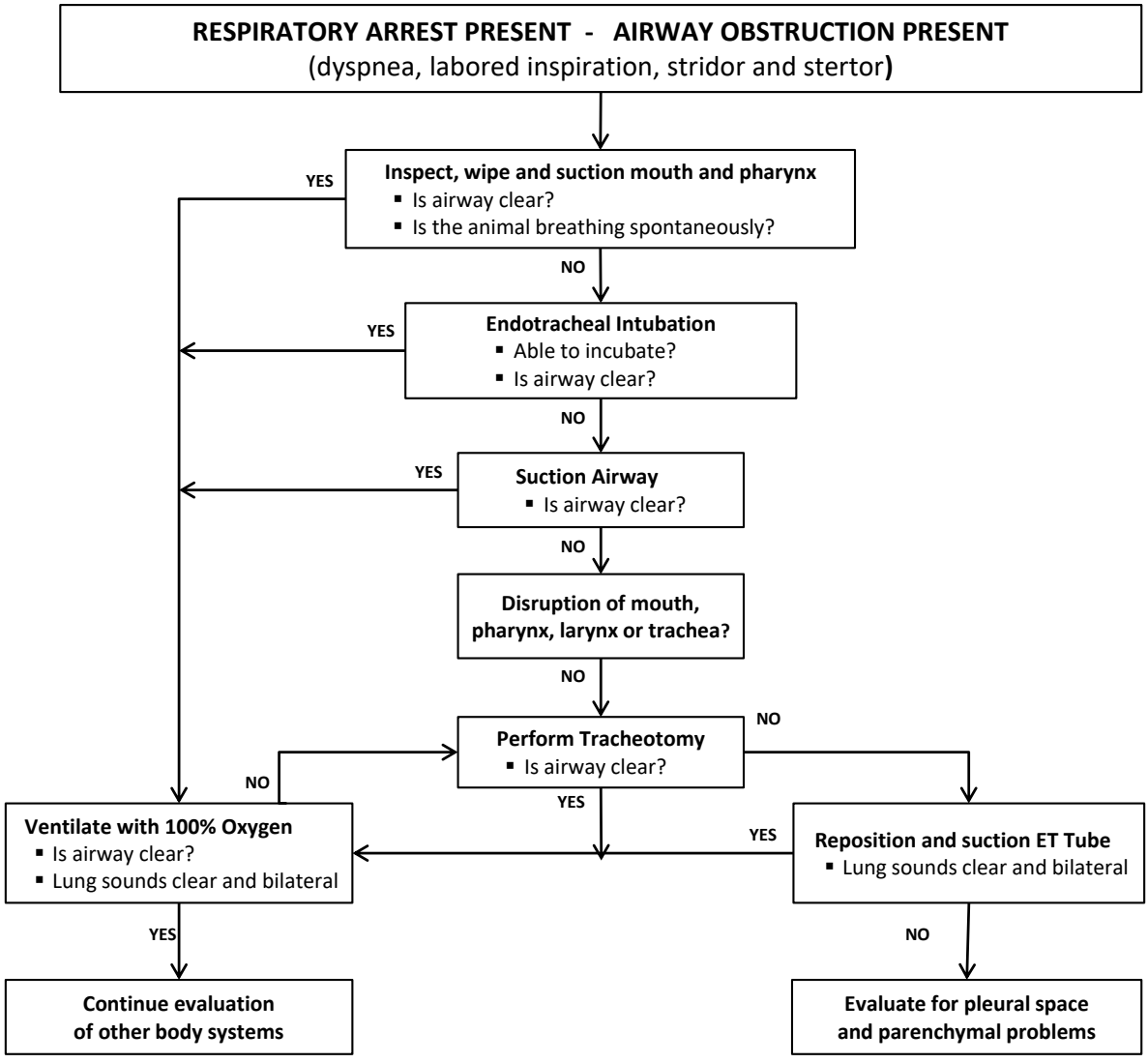
Penetrating Chest Wounds & Respiratory Distress

Respiratory distress develops in deployed MWDs most commonly due to trauma. MWDs in respiratory distress are fighting to get oxygen: they are anxious, usually have obvious problems breathing, usually have their head and neck extended, elbows and upper legs held out from the chest, don't want to lie down, and fight restraint and handling. Cyanosis, if present, is a late finding.

MWDs in respiratory distress typically have 1 of 3 characteristic breathing patterns that help localize the problem. A clinical algorithm for differentiating the most likely cause of a patient's distress based on the pattern of breathing is provided (See Figure 26).

Provide supplemental oxygen for any dog in respiratory distress (See Chapter 3).

Figure 26. Clinical Algorithm for Differentiating Cause of Distress Based on Breathing Pattern.[1]



Thoracic Radiography and Thoracic Focused Assessment with Sonography in Trauma (TFAST)

Thoracic radiography and TFAST exams are useful adjunct procedures, especially in the diagnosis and treatment of pneumothorax, hemothorax, pleural effusion, pulmonary contusions, or pulmonary edema. Radiography is also appropriate for documentation of correct thoracostomy tube placement.

Perform thoracic radiography on every traumatized MWD, if available, even if there is no clinical evidence of thoracic trauma. A significant number of trauma patients without outward evidence of chest trauma have hidden trauma that may manifest later, complicate management, or worsen with treatment of other conditions.

TFAST should be performed on every MWD that presents with a history of trauma, if the HCP has significant experience in its use; TFAST requires a high degree of experience to optimize diagnostic reliability. As with human casualties, TFAST is sensitive and specific for the diagnosis of pneumothorax and pulmonary parenchymal fluid, and for rapidly evaluating for pericardial and pleural effusions.[4] Figure 27 shows the imaging locations for TFAST in the dog. Figure 28 describes a clinical management algorithm for the use of TFAST in dogs.

Figure 27. Imaging Locations for TFAST.[4]
Figure 27 shows the ultrasound probe locations for TFAST in the dog.

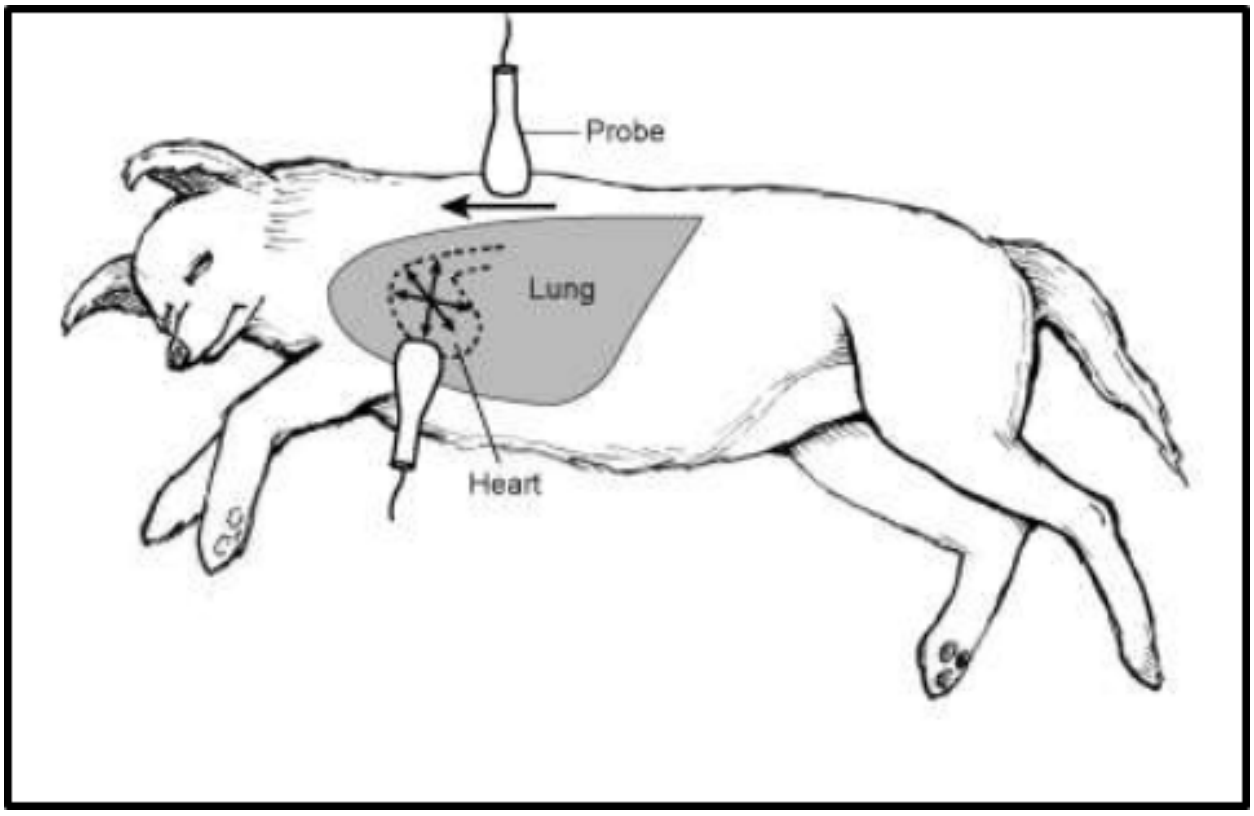
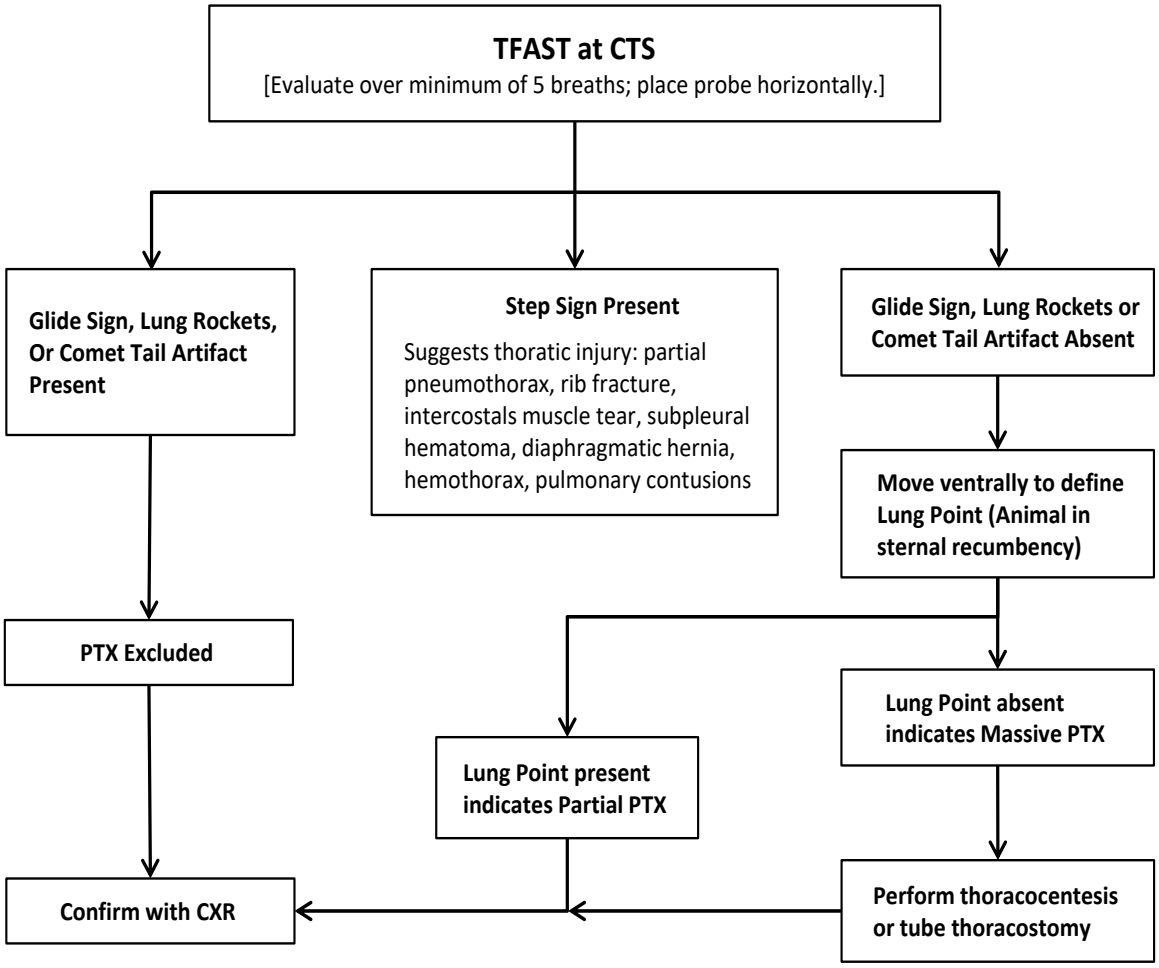


Figure 28. Clinical Management Algorithm for TFAST Use in Military Working Dogs.[4]


TFAST at CTS
[Evaluate over minimum of 5 breaths; place probe horizontally.]
Glide Sign, Lung Rockets, Or Comet Tail Artifact Present
Step Sign Present
Suggests thoratic injury: partial pneumothorax, rib fracture, intercostals muscle tear, subpleural hematoma, diaphragmatic hernia, hemothorax, pulmonary contusions
Glide Sign, Lung Rockets or Comet Tail Artifact Absent
Move ventrally to define Lung Point (Animal in sternal recumbency)
PTX Excluded
Lung Point absent indicates Massive PTX
Lung Point present indicates Partial PTX
Confirm with CXR
Perform thoracocentesis or tube thoracostomy

Note: CTS refers to probe imaging location at the conventional Chest Tube Site (8th-11th intercostal space). PTX refers to pneumothorax. CXR = thoracic radiography.

Thoracic Injury

Up to 50% of traumatized dogs have some form of thoracic injury.[5-12] Pneumothorax (PTX) and pulmonary contusions are very common. Dogs with thoracic injury typically have restrictive and parenchymal breathing patterns (See Figure 26).

Rib Cage Trauma

This includes flail chest, rib fractures, intercostal muscle rupture, and penetrating wounds. Signs mimic pleural space injury (restrictive breathing pattern). Usually the defect is obvious, especially if paradoxical chest wall motion is noted.

- Adequate management usually involves careful handling, laying the patient with affected side down, minimizing restrictive chest bandaging, and providing analgesia. External splinting or surgical management is usually not necessary unless injury is severe or extensive, or the chest wall is compromised and prolonged interference with gas exchange and ventilation is evident.
- Pain can substantially interfere with gas exchange and ventilation. Alleviate pain once the patient is stabilized to improve oxygenation and ventilation. Systemic or local analgesia are acceptable options (See Chapter 16). Local nerve/rib blocks and intrapleural analgesia administration work well and are readily accomplished.

Pleural Space Trauma

This includes PTX (open, closed, tension), hemothorax (HTX), and diaphragmatic hernia. A restrictive breathing pattern is the classic presentation—shallow, rapid respiration with muffled lung and/or heart sounds. Auscult the chest for decreased lung sounds over most of the thorax, which suggests either fluid (blood) or air in the pleural space, pulmonary contusions, or diaphragmatic hernia.

- Open PTX requires immediate action. Rapidly clip hair from around the wound, and apply any occlusive seal over the wound. Apply a chest bandage to secure the material. Delay wound closure until the MWD is stable. Open PTX always requires chest decompression after closure of the wound.
- The presence of decreased lung sounds in a trauma patient with signs of respiratory distress, or rapid clinical deterioration in a MWD with respiratory distress is sufficient justification for needle thoracocentesis.
- Thoracocentesis is readily and rapidly accomplished, and safe when performed properly – "When in doubt, tap it!" Figure 29 on the next page shows the location for needle thoracocentesis in dogs.[13] See Table 8 for thoracocentesis technique in MWDs.
- The mediastinum in dogs is thin and typically ruptures; therefore, ***always tap both sides of the chest***, even if a positive tap is achieved on one side of the chest, as air will form pockets and will migrate.
- Repeated thoracenteses may be required to stabilize the patient. A negative chest tap doesn't always mean there's not an abnormal accumulation of air or fluid in the pleural space – it may mean you just couldn't find it! "When in doubt, tap it again!"
- In dogs, the intercostal artery, vein, and nerve run on the caudal aspect of each rib; thus, the best approach is by inserting the needle or catheter in the center of the intercostal space or at the cranial aspect of a rib.

Figure 29. Location for Needle Thoracocentesis.

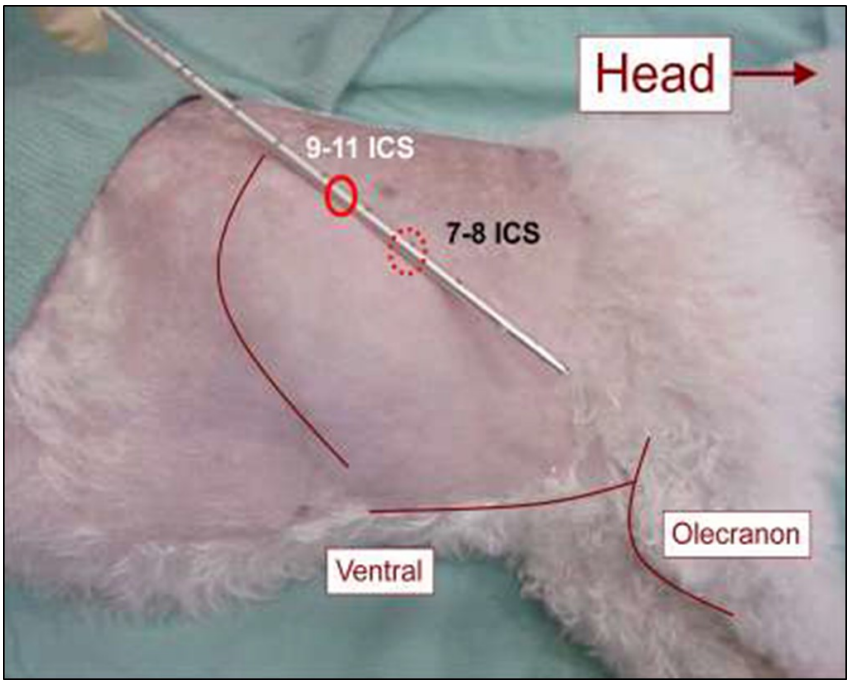
Figure 29 shows anatomic location for needle thoracocentesis in dogs, with the dog in lateral or sternal recumbency, and the needle inserted generally on the mid-lateral thorax between the 6th to 8th intercostal space. Count forward from the last rib (#13; red dotted line) to find the insertion site.

Immediate placement of a thoracostomy tube is indicated if negative pressure cannot be achieved with needle thoracocentesis, if large amounts of blood are aspirated, or if repeated thoracocenteses are required to maintain negative pleural pressure.

- A general rule of thumb for thoracostomy tube sizes is the chest tube should be the largest size that comfortably fits in the intercostal space. For most MWDs, use fenestrated tubes that are 24-36 Fr. Figure 30 shows the correct anatomic orientation for chest tubes placed in dogs. Table 9 describes techniques for chest tube placement in MWDs.
- Tube thoracostomy is a painful procedure. In emergent or critically ill patients, local analgesia may not be necessary. Consider local anesthesia, intercostal nerve blocks, and intrapleural analgesia in all other patients (See Chapter 16).
- Remove chest tubes when air or fluid accumulation is less than 2-4 mL/kg body weight per day.
- The chest tube will ideally lie in the pleural space, generally oriented cranioventrally to maximize removal of air and fluid. It is best to pre-measure the tube visually before placement to ensure proper depth of insertion. Be certain the last fenestration of the tube will be within the chest cavity.
    - Patients with chest tubes in place MUST be monitored continuously!
    - Some form of removal of air or fluid must be used. This can be continuous suction or intermittent aspiration by personnel.

Figure 30. Anatomic Orientation for Chest Tube Placement.

Figure 30 shows correct placement of a chest tube on the lateral aspect of the chest in a dog, with the tube penetrating the skin at the 9th to 11th intercostal space (ICS), tunneling cranioventrally to penetrate the chest wall at the 7th to 8th ICS, directed toward the olecranon of the elbow. Photo courtesy of Dr. Tim Hackett.



Resuscitative Thoracotomy

- Emergent thoracotomy may be indicated, keeping in mind caveats discussed previously.
- Thoracotomy in dogs is generally best done through a LEFT lateral thoracic wall approach, generally at the 4th to 5th or 5th to 6th intercostal space to afford optimal visualization. A median approach is not recommended in MWDs, given difficulties in post-operative management.
- Euthanasia should be considered for a MWD for which a resuscitative thoracotomy is deemed necessary but cannot be performed or has proven unsuccessful (See Chapter 21).

Parenchymal Trauma

Pulmonary contusions and intrabronchial hemorrhage are common. A restrictive breathing pattern may be noted in patients with mild and moderate parenchymal injury. Patients with severe parenchymal injury often have a parenchymal pattern, seen as respiratory distress with labored inspiration and expiration, with or without hemoptysis.

- Auscult the chest for decreased lung sounds, which suggest either fluid (blood) or air in the pleural space, or pulmonary contusions. A patchy distribution of altered lung sounds may be noted, which helps differentiate parenchymal injury from pleural space trauma.

- A negative thoracocentesis suggests the presence of pulmonary contusions in patients with these clinical signs. Note that radiographic signs (mixed interstitial-alveolar pattern) may lag 12-24 hours, and the stress of the process is usually not warranted.
- Hemoptysis, especially of arterialized (bright red) blood suggests significant large pulmonary vessel trauma that typically carries a very guarded prognosis.
- Most MWDs with pulmonary contusions do not require mechanical ventilation. Management of pulmonary contusions involves minimizing stress, providing oxygen supplementation, cautious intravenous fluid administration to prevent progression of contusions and/or development of pulmonary edema, and possible addition of colloids to the fluid therapy plan to decrease the amount of lung water that may accumulate during shock resuscitation. Diuretics and steroids are not indicated in treatment of pulmonary contusions, and may increase patient morbidity and mortality.
- Severe, life-threatening major pulmonary vessel hemorrhage may require resuscitative thoracotomy. Refer to the discussion of **Resuscitative Thoracotomy** in this chapter for guidance and technique.

Diaphragmatic Hernia

Auscultation of borborygma over the area of the lung field suggests the presence of a diaphragmatic hernia, but can be misleading. Standard radiography and ultrasonography procedures are diagnostic. Assume a hernia is present, and carefully manage the patient to minimize discomfort and further organ herniation until the patient is stable enough to allow definitive diagnosis of the hernia.

- ***Diaphragmatic hernia (DH) is usually not considered a surgical emergency unless the stomach is involved, or the patient's condition deteriorates or fails to respond to conservative management.*** In most cases, the patient should be stabilized for shock and other organ injury, with definitive repair of the hernia at a later time. Most patients suffering trauma severe enough to rupture the diaphragm have other pulmonary injuries that would preclude anesthesia and intermittent positive pressure ventilation (IPPV) (e.g., contusions, pneumothorax).
- Emergent repair of a DH may be indicated. Repair is performed via a cranial ventral midline laparotomy, with retraction of the liver and stomach caudally, to afford optimal visualization.
  - Some means of positive pressure ventilation is necessary intraoperatively.
  - At least 1 thoracostomy tube should be placed intraoperatively and maintained for at least 24 hours post-operatively to manage pneumothorax.
  - Generally, rents in the diaphragm due to trauma occur in the muscular portions of the diaphragm, and are readily repaired using a simple continuous suture closure.

Ventilatory Support

Ventilatory support (e.g., manual IPPV or mechanical ventilation) may be required for dogs that fail to respond to correction or stabilization of the primary respiratory problem and supplemental oxygen support.[15] Ventilatory support requires a heavily sedated or anesthetized patient, even if a tracheostomy tube is in place (See Chapter 16).

- Manual intermittent positive pressure ventilation (MIPPV) is feasible if personnel can be spared for this, and is ideal for short-term (i.e., <6 hours) of ventilator support.
- There may be instances in which mechanical ventilation (MV) is necessary to afford a chance for patient survival. MV may be necessary if MIPPV fails or duration of ventilator support is expected to be >6 hours. Providers must note that MV should be considered only if the provider has the necessary advanced MV training and experience, the provider feels there is a reasonable likelihood of success, and the provider has the necessary support staff, facilities, and monitoring and intensive care facilities to manage a MWD on MV without compromising human patient care. Thus, MV should be considered only in Level 2 or higher medical facilities and by trained specialists with adequate staff.
- Generally, it is best to induce general anesthesia and initially manage the ventilated dog using Controlled Ventilation or Assist-Control ventilator mode. Key ventilator settings are shown (See Table 7).

TABLE 7: MECHANICAL VENTILATOR SETTINGS & KEY PARAMETERS[13]

PARAMETER	NORMAL LUNGS	ABNORMAL LUNGS
F_IO_2	100%, then reduce to <60%	100%, then reduce to <60%
Tidal Volume (V_T)	5 – 15 mL/kg	5 – 15 mL/kg
Breathing Rate (f)	8 – 20 bpm	8 – 20 bpm
Minute Ventilation (V_E)	150 – 250 mL/kg/min	150 – 250 mL/kg/min
Peak Inspiratory Psi (PIP)	10 – 20 cmH_2O	15 – 25 cmH_2O
Positive End-Expiratory Psi (PEEP)	0 – 2 cmH_2O	2 – 8 cmH_2O
Trigger Sensitivity	-2 cmH_2O or 2 L/min	-2 cmH_2O or 2 L/min
Inspiratory: Expiratory Ratio (I:E)	1:2	1:2
Inspiratory Time	~ 1 sec	~ 1 sec

TABLE 8. NEEDLE THORACOCENTESIS OF MWDS[14]

1. Position the animal in sternal recumbency if conscious or lateral recumbency if unconscious, sedated, or anesthetized.
2. Clip the hair from and surgically prepare a 6 inch X 6 inch square area of skin on the mid-lateral aspect of the thorax centered between the 6th to 8th ribs.
   - If pneumothorax is suspected, prepare the thoracenteses sites at the junctions of the upper 1/3rd and lower 2/3rds of the thoracic wall.
   - If pleural effusion is suspected, prepare the thoracenteses sites at the costochondral junctions.
3. In conscious MWDs and if time, infiltrate 1 mL of local anesthetic (20 mg lidocaine or 5 mg bupivacaine) in the skin to the pleura.
4. Assemble an emergency thoracocentesis set. For a tension PTX, a 1-1.5 inch, 16-18 gauge over-the-needle catheter is sufficient to relieve tension. For other types of PTX, use a 1-1.5 inch, 18 gauge over-the-needle catheter, to which sterile extension tubing and a stopcock and 60 cc syringe are attached; this allows aspiration of air and fluid without iatrogenic PTX. ***Do NOT use the standard Needle Decompression Device (3.25 inch, 16 gauge), as risk of cardiac or pulmonary vessel trauma is high.***
5. Hold the needle with the thumb and index finger of one hand and brace the hand on the lateral aspect of the thorax by firmly resting the "knife" of the hand on the thorax near the proposed thoracocentesis site.
6. Hold the syringe in your dominant hand, or have an assistant manipulate the syringe and stopcock while you manipulate the needle. The syringe should be empty and the stopcock closed to room air.
7. While stabilizing the hand holding the needle, insert the needle at the proposed thoracocentesis site through the skin, intercostal muscles, and parietal pleura until ½ the length of the needle has been inserted.
8. While stabilizing the depth of the needle with your non-dominant hand, aspirate with the syringe plunger in an attempt to remove air or fluid.
9. If you are successful in removing air or fluid, close the stopcock to the patient and expel the contents from the syringe through the stopcock without removing the needle from the pleural space or breaking aseptic technique.
10. Repeat until no further air or fluid can be removed.
11. If you are not successful in removing air or fluid, insert the needle to the hub while aspirating with the syringe, or redirect the needle cranially, caudally, dorsally and ventrally, or do both in an attempt to tap a pocket of air or fluid.
12. If you are still unsuccessful in removing air or fluid, completely remove the needle from the thorax and attempt thoracocentesis in an intercostal space cranial or caudal to the initial site.

TABLE 9. TUBE THORACOSTOMY OF MILITARY WORKING DOGS[15]

1. Clip the hair from and surgically prepare an area of skin from the 4th to the 12th rib, and from the dorsal midline to the ventral midline.

2. Infiltrate local anesthetic (20 mg lidocaine +/- 10 mg bupivacaine) at the proposed skin incision site between the 9th and 11th intercostal space at the junction of the upper 1/3rd and the lower 2/3rds of the lateral thorax. Continue infiltration of the subcutaneous tissues cranioventrally to the intercostal space at the intended site of penetration of the thoracic wall between the 6th and 8th intercostal space. Infiltrate the intercostal muscles, down to the level of the parietal pleura.

3. Make a skin incision with a #10 scalpel blade that is the same diameter as the thoracostomy tube. Note that an incision that is too large increases the risk of iatrogenic PTX and fluid leakage.

4. Insert the thoracostomy tube using either a trocar or forceps through the skin incision and advance the tube cranioventrally toward the intercostal space where you intend to penetrate the thorax. This creates a subcutaneous tunnel and orients the tube to lie in the intended direction in the chest.

   Note: *The interval between the skin incision and the intercostals space where the tube penetrates the thorax must be at least 2 intercostal spaces in width to allow sufficient creation of a subcutaneous tunnel that is important in minimizing iatrogenic PTX and fluid leakage.*

   Note*: MWDs rarely develop pleural adhesions, so digital exploration before tube placement is not necessary.*

   Trocar Technique: (RECOMMENDED technique)

   1) Insert the tip of the tube through the skin incision and advance the tube subcutaneously cranioventrally at least 2 intercostal spaces. Be sure to hold the trocar firmly in the tube.
   2) Firmly drive the tip of the stylet into the intercostal musculature as you raise the thoracostomy tube vertically so that the tube is almost perpendicular to the thorax.
   3) This movement will cause the skin to bunch over the intercostal space and will expose the distal part of the tube that was in the skin tunnel.
   4) Firmly grasp the distal-most part of the thoracostomy tube with one hand approximately 2 cm from the tip to prevent inadvertent over insertion of the trocar when advancing the tube in the next step. Note that this step is vital, as this hand acts as a “brake” to prevent lung and heart trauma as the tube is inserted.
   5) Using either a single, sharp blow to the proximal blunt end of the stylet or firm continuous downward pressure on the proximal blunt end of the stylet, penetrate the intercostal muscles and pleura to advance the tube into the pleural space approximately 2 cm.
   6) Once the tip of the thoracostomy tube has been inserted approximately 2 cm into the pleural space, lay the tube flat against the body wall AS YOU BEGIN TO ADVANCE THE TUBE in the pleural space cranioventrally toward the point of the elbow.
   7) As the tube is advanced, begin to slide the stylet out of the tube.
   8) Clamp the thoracostomy tube using the box lock of the Rochester-Carmalt or similar forceps as the stylet is removed to prevent pneumothorax.
   9) Close the proximal (outer) opening of the thoracostomy tube using either a Heimlich valve or tubing adapter and stopcock so that air does not enter the pleural space.

TABLE 9. TUBE THORACOSTOMY OF MWDS[15] (CONTINUED)

Forceps Technique: (NOT ideal; more traumatic and technically demanding)

1) Create a subcutaneous tunnel by bluntly advancing a 7" curved Rochester-Carmalt forceps or similar forceps (without the tube) cranioventrally from the skin incision site to the proposed intercostal space where the thoracostomy tube will penetrate the thorax.
2) Forcefully drive the tip of the forceps through the intercostal muscles and parietal pleura using a firm, quick thrusting motion, to enter the chest cavity.
3) While the tips of the forceps are inserted through the intercostal muscles and pleura, firmly open the jaws of the forceps to dilate the penetration site in the thoracic wall.
4) Remove the forceps and grasp the distal end of the thoracostomy tube with the jaws of the forceps such that the length of the tube is lying over the handles of the forceps. Just a small part of the tip of the tube should extend beyond the tip of the forceps.
5) Attach a Heimlich valve or clamp the thoracostomy tube BEFORE placing the tube to prevent pneumothorax.
6) Insert the forceps holding the tube through the skin incision and advance the tube and forceps cranioventrally through the subcutaneous tunnel to and through the intercostal opening.
7) Without removing the forceps, open the jaws of the forceps to release the thoracostomy tube. Advance the thoracostomy tube into the pleural space in a cranioventral direction toward the point of the elbow.
8) As the thoracostomy tube is advanced into the pleural space, slowly remove the forceps completely.
9) Continue to advance the thoracostomy tube until you are absolutely certain the most proximal fenestration of the tube is well within the pleural space, and is not in the subcutaneous tunnel or outside the skin.

5. Secure the chest tube to the skin using a horizontal mattress suture through the skin ventral to the skin tunnel, a purse string suture at the skin incision site that surrounds the tube where it enters the skin, and a "finger trap" suture around the tube anchored to the skin. Incorporate the chest tube in a bandage applied around the thorax to protect the tube.

References for Penetrating Chest Wounds & Respiratory Distress

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CHAPTER 5

Cardiopulmonary Resuscitation (CPR)

Indications for CPR

HCPs should consider CPR of MWDs in cases of non-traumatic cardiopulmonary arrest (anesthesia-related, hypothermia, near drowning, electrocution). If the tactical situation and resources permit, HCPs may consider CPR in MWDs with CPA due to blast injury, blunt trauma, or penetrating trauma, although successful resuscitation in these cases is unlikely. Overall survival in dogs is approximately 5%.

Clinical Management Algorithm for CPR

In general, CPR is performed in much the same manner as for people.[1] Management guidelines for CPR in dogs are provided (See Figure 31 and Table 10).

Basic Life Support[2-4]

2-person, closed-chest CPR should be initiated as soon as CPA is declared.

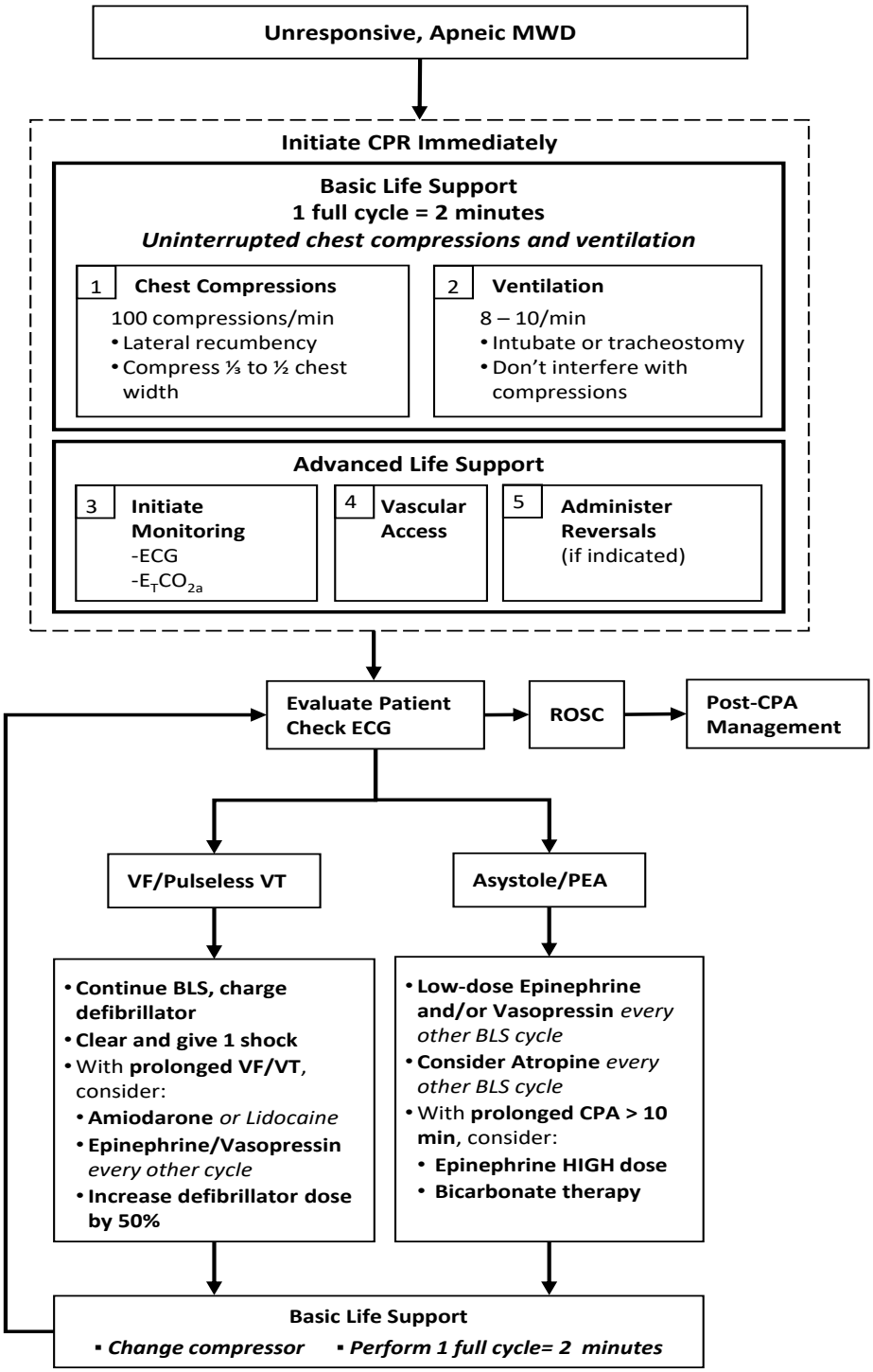
- Circulation – Immediately begin sustained, forceful chest compressions with the MWD in lateral recumbency (on either side) at a rate of 100 compressions per minute. Sustain compressions for at least 2-3 minutes per cycle. Hand placement can be directly over the heart (where the elbow crosses the chest above the sternum when the forearm is pulled caudally) or over the widest part of the chest (See Figure 32). Ensure adequate relief of downward pressure during the relaxation phase of the compressions. As for people, "PUSH HARD and PUSH FAST."[1]

- Airway – Establish an airway as rapidly as possible and as soon as possible after identifying a patient in CPA. However, start chest compressions first! Intubate the MWD if possible; if intubation is not possible, perform an emergent tracheostomy without delay (See Chapter 2).

- Breathing – Ventilate the patient at a rate of 8-10 breaths per minute. Avoid hyperventilation. Give oxygen if available; room air is acceptable if oxygen is not available.

Figure 32. Positioning for Canine CPR.

Figure 31. CPR Algorithm for Military Working Dogs.[2]



Clinical algorithm for canine cardiopulmonary resuscitation. Adapted from Cole SG, Otto CM, Hughes D. Cardiopulmonary-cerebral resuscitation in small animals–a clinical practice review, Part II. J Vet Emerg Crit Care 2003;13:1323. Used with permission

Advanced Life Support[5]

Initiate ALS as soon as feasible, with ECG monitoring to guide management. Figure 31[2] and Table 10 direct specific actions based on the arrest rhythm present. In contrast to people, the most common arrest rhythm in MWDs is pulseless electrical activity (PEA; 24%), followed by asystole (23%), and then ventricular fibrillation (VF; 20%). Sinus bradycardia commonly precedes arrest in many situations in dogs.[2,5]

- 70% of MWDs that arrest will have PEA, asystole, or sinus bradycardia as the initial arrest rhythm.[2,5] Epinephrine or vasopressin are best choices for these rhythms or for empiric use if ECG capability is not available. In the deployed setting, there is no role for transthoracic pacing in MWDs with PEA or asystole.
- Bradycardia due to a pronounced vagal response is very common in dogs, and use of atropine may prevent development of cardiopulmonary arrest.
- VF, while present initially in only 20% of MWDs with an arrest rhythm, often develops during resuscitation.[2] Perform external defibrillation if possible and as rapidly as possible if VF is noted; biphasic defibrillation is ideal.[5,7] Apply paddles to either side of the chest with the MWD in dorsal recumbency (on its back), or place a flat paddle under the MWD lying in lateral recumbency and a standard paddle on the upper chest wall. Defibrillate up to 3 times at each energy level if prior attempts are not successful, but perform aggressive chest compressions for at least 2 minutes before attempting each defibrillation.
- IV access is critical. Place multiple IV or IO catheters or perform venous cut-down (See Chapter 6, Figure 33). Follow all drugs with a 10 mL saline push. Do not give large volumes of fluids to MWDs during CPR, unless severe hypovolemia is thought present. Give fluids initially to facilitate drug delivery only.

Tips for Successful CPR in MWDS[2,3]

- Avoid interrupting chest compressions! The key to successful resuscitation is to SUSTAIN chest compressions aggressively for 2-3 minutes before stopping to check status.
- Most people apply too little force when performing chest compressions! Do not be concerned with breaking ribs or injuring the heart or chest with BLS. In contrast to CPR in people, the thorax of MWDs is more compliant and fractures are rare.
- Maintain a steady and continuous rate of chest compression and ventilation. Minimize the number of times you stop to check the patient. Most people stop too frequently, which makes BLS less successful.
- During CPR, consider sodium bicarbonate (1-2 mEq/kg IV, repeated every 10 minutes) if metabolic acidosis (pH <7.0) is present, or empirically if CPR is prolonged >10 minutes.
- During CPR, consider magnesium sulfate (30 mg/kg IV, once) in patients with refractory VT.

Single Person CPR

Single-person CPR on dogs is extremely challenging, with very poor success rates, and should be initiated only if other personnel are immediately nearby and can be mobilized to assist in 1-2 minutes. If single-person CPR is performed, the responder should only perform chest compressions, as this optimizes circulation.

Post-Resuscitation Care[6]

Resuscitated MWDs will require intensive care to optimize long-term outcome. Many MWDs will arrest again, and most do so in the first 4 hours after resuscitation.[2,3] Successful return of spontaneous circulation and resuscitation are unlikely if an MWD arrests again, and HCPs should balance resources against repeated attempts at resuscitation. Key management issues for MWDs in the post-resuscitation phase follow.

- Control seizures that develop with diazepam or midazolam (0.3 mg/kg; IV, IO, or intranasally), repeated every 15-30 minutes if necessary. If available, give phenobarbital (15 mg/kg IV or IO) loading dose, and 2.5 mg/kg IV every 12 hours thereafter if seizures persist or status epilepticus develops.
- Prevent and reduce cerebral edema. Use mannitol (1 gram/kg, IV, twice, 4-6 hrs apart), avoid hyperventilation, give a single dose of dexamethasone (0.5 mg/kg IV) or methylprednisolone sodium succinate (30 mg/kg, IV, once), avoid jugular vein compression, and maintain normoxemia and normotension.
- Maintain adequate ventilation, maintaining a patent airway and using manual IPPV at 8-10 breaths per minute, targeting an E_TCO_2 of 25-60 mmHg.
- Maintain adequate oxygenation, targeting a SpO_2 > 95% using supplemental oxygen for a minimum of 12 hours.
- Maintain normotension using IV fluids in bolus challenges, targeting a MAP > 65 mmHg or Sys > 90 mmHg. Isotonic crystalloids at 10-15 mL/kg over 15 minutes are usually effective.
- Use synthetic colloids if 2-3 bolus challenges do not achieve normotension. Give 2-3 bolus challenges of hydroxyethyl starch (HES) at 10 mL/kg over 15 minutes. Once normotension is achieved, give crystalloid IV fluids at 3-5 mL/kg/hour for maintenance. Given the dismal outcome in post-resuscitation MWDs that require vasopressor support, there is no role in the deployed setting for vasopressor therapy in MWDs in the post-resuscitation phase.
- Control pathologic ventricular arrhythmias with a lidocaine CRI (50-75 mcg/kg/min).
- Do not attempt tight control of blood glucose with insulin. Supplement IV fluids if hypoglycemia is present (5% dextrose), but avoid hyperglycemia.
- There is no role for therapeutic hypothermia in MWDs during the post-resuscitation period. Avoid hyperthermia; tolerate mild hypothermia (>92° F) if it develops.

Discontinuation of CPR

CPR should be discontinued 1) if the animal is successfully resuscitated, 2) if the senior HCP directs that efforts cease, or 3) if effective CPR has been attempted for at least 20 minutes without success.

Resuscitative Thoracostomy and Open-Chest CPR

There is no role for open-chest CPR by HCPs in MWDs. Euthanasia is indicated for any MWD for which a resuscitative thoracostomy is deemed necessary to manage CPR (See Chapter 21).

TABLE 10. MWD CPR PROTOCOL.[2-7]

BASIC LIFE SUPPORT		
Focus	**Actions**	**Comments**
CIRCULATION	IMMEDIATE chest compressions FAST and HARD -- 100/min	SUSTAIN for 2 minute cycles!
AIRWAY	Clear airway > Intubate or Tracheostomy	Don't interfere with compressions!
BREATHING	Manually ventilate (100% oxygen) 8-10 breaths/min	Don't hyperventilate!

ADVANCED LIFE SUPPORT

- ECG interpretation is essential
- Venous access is critical -- Place multiple peripheral lines and/or IO catheters -- Consider central line when able
- Follow all drugs with 10 mL saline push
- Do NOT give large volumes of fluids during CPR, unless the MWD is hypovolemic

ASYSTOLE, PEA, SINUS BRADYCARDIA		
Drugs	**Dose and Route**	**Comments**
VASOPRESSIN ***and*** EPINEPHRINE	0.8 U/kg -- IV or IO — ***ONCE!*** 0.01 mg/kg -- IV or IO	70% of arrests have these initial arrhythmias. These drugs are best for empiric use if ECG is not available, or if indicated by ECG.
…and…		
ATROPINE	0.04 mg/kg -- IV or IO ***only if bradycardia preceded arrest***	

VENTRICULAR FIBRILLATION or PULSELESS VENTRICULAR TACHYCARDIA		
ELECTRICAL DEFIBRILLATION	2 - 5 Joules/kg (biphasic) 4 – 6 J/kg (monophasic)	Only 20% of patients present initially with these arrhythmias. However, V Fib and pulseless V tach often develop during CPR.
	Immediately start compressions for 1 cycle after every defib attempt	
	Defibrillate TWICE more if needed at same energy level, BUT ***resume chest compressions for 1 cycle after each defib***	
…DRUG THERAPY if DEFIBRILLATION UNSUCCESSFUL…		
EPINEPHRINE	0.01 mg/kg -- IV or IO	Give SODIUM BICARBONATE every 10 minutes during CPR if pH is <7.0 or CPR is prolonged more than 10 minutes. **1-2 mEq/L, IV**
…or…		
VASOPRESSIN ***and*** LIDOCAINE	0.8 U/kg -- IV or IO -- ***ONCE!*** 2 mg/kg -- IV or IO	
…or…		Give MAGNESIUM SULFATE if patient has refractory VENTRICULAR TACHYCARDIA. **30 mg/kg, IV, once**
AMIODARONE	5 - 10 mg/kg -- IV or IO	
DEFIBRILLATE at 50% INCREASED energy if REFRACTORY		

TABLE 10. MWD CPR PROTOCOL.[2-7] (Continued)		
POST-RESUSCITATION MANAGEMENT		
▪ Maintain NORMOTENSION -- Target MAP of >65 mmHg or Systolic BP >90 mmHg ▪ Maintain VENTILATION -- Target RR of 8 - 10 bpm -- Target E_TCO_2 of 25 - 60 mmHg; consider IPPV/MV if needed ▪ Maintain OXYGENATION -- Target SpO_2 >95% with supplemental oxygen as needed		
CONTROL SEIZURES		
MIDAZOLAM or DIAZEPAM		0.3 mg/kg -- IV, IO, or INTRANASAL *prn*
MANAGE CEREBRAL EDEMA		
MANNITOL	1 - 2 grams/kg -- IV over 30 min	▪ Avoid HYPERVENTILATION ▪ Avoid JUGULAR VENOUS ▪ COMPRESSION ▪ Avoid HYPERTHERMIA ▪ Tolerate MILD HYPOTHERMIA
and		
DEXAMETHASONE	0.5 mg/kg -- IV -- ONCE	
…or…		
METHYLPREDNISOLONE	30 mg/kg -- IV -- ONCE	
CONTROL PATHOLOGIC VENTRICULAR ARRHYTHMIAS		
LIDOCAINE	CRI @ 50 - 75 mcg/kg/min	CORRECT H's and T's FIRST
CONTROL HYPOGLYCEMIA		
SUPPLEMENT IV fluids with 5% dextrose -- MONITOR blood glucose q4-6 -- AVOID intensive glucose titration		

CPR References

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CHAPTER 6

Shock Management

Shock in deployed MWDs will most likely be due to hemorrhage from trauma or hypovolemia due to heat injury or gastrointestinal losses. Control bleeding (if present) and then stabilize the patient using targeted fluid therapy. Figure 33 provides a clinical management algorithm for shock management in MWDs.

Immediate Hemorrhage Control

Treatment by handlers and combat medics may have been performed, with varying degrees of success.[1,2] Expect dogs to arrive with pressure dressings, hemostatic gauze packed into wounds, and improvised tourniquets. Expect untreated or inadequately treated extremity hemorrhage, and suspect "hidden" intracavitary hemorrhage in the chest and abdomen.

- Assess for unrecognized hemorrhage and control all sources of external bleeding. Use direct pressure initially, or rapidly clamp and ligate major vessels if traumatized. Dogs have excellent collateral circulation, and paired major vessels can be ligated without concern for tissue ischemia or edema, to include the femoral arteries and veins, external jugular veins, external carotid arteries, and brachial arteries and veins.[3,4]
- Tourniquets are unreliable on the limbs of dogs due to the anatomic shape of the leg. Conventional human tourniquets do not remain in place or effectively control hemorrhage. Some success is reported in use of improvised tourniquets, such as surgical rubber tubing or constrictive gauze bandage. If delay in definitive care of major extremity trauma is expected, use hemostatic agents, direct pressure, and compressive bandaging to assist with hemorrhage control.
- Use thoracic FAST (TFAST) and abdominal FAST (AFAST) to rapidly scan for intracavitary fluid (See Chapter 4 and Chapter 7).[5,6] Assume intracavitary fluid is due to bleeding until proven otherwise.

Clinical Signs of Shock in MWDs[7,8]

Dogs in shock are amazing in how stable they appear on initial presentation, due to compensatory mechanisms.

- MWDs in early (compensatory) shock may have tachycardia, tachypnea, alert mentation, rapid arterial pulses with a normal or increased pulse pressure, decreased capillary refill time (< 2 seconds), and normal or bright red mucous membranes. While this MWD seems normal, it is already in compensatory shock. Immediate treatment at this point may stop the progression of shock.
- As the early decompensatory phase of shock begins, tachycardia persists, pulse pressure and quality begins to drop or may be normal, capillary refill time becomes prolonged, mucous membranes appear pale or blanched, peripheral body temperature drops, and mental depression develops. Aggressive treatment must be provided to halt ongoing shock.
- As late decompensatory shock develops, the heart rate drops despite a decreased cardiac output, capillary refill time is very prolonged or absent, pulses are poor or absent, both peripheral and core temperature is very low, and marked mental depression (stupor) is present. Irreversible cellular injury may be present to such a severe degree that despite aggressive measures at this point, many patients will die.

Standard Shock Therapy

Provide immediate fluid therapy targeted to specific endpoints, provide supplemental oxygen, and identify and treat the cause for the shock. Tranexamic acid (TXA) or ε-aminocaproic acid (EACA) may be helpful in dogs with catastrophic hemorrhage.

1. Place multiple large-bore IV or IO catheters or perform venous cut-down.

   - Do not delay in placing catheters. *The IO route is rapid, reliable and safe — USE IT!* Place peripheral or central lines when feasible. If one percutaneous attempt is not successful in a shock patient, immediately choose an alternate percutaneous site and also begin an immediate venous cutdown or perform IO catheterization. The cephalic veins and external jugular veins are ideal for peripheral catheterization.

   - The proximal cranial medial tibia and the proximal lateral humerus are ideal for IO catheter placement, using the same technique as for people (See Figures 34-37). Most MWDs weigh >40#, so use adult (25mm X 15 gauge) IO catheters. Use pediatric (15mm X 15 gauge) IO catheters in dogs weighing less than 40#.

2. Give crystalloid fluids as the first-line treatment.[9-14]

   - Normosol-R® or Plasmalyte-A® are optimal for dogs; however, saline or LRS are acceptable in emergent cases.

   - Crystalloid fluid challenges, as needed based on response to therapy, are better than large volume fluid administration.[11-13] Be prepared to administer up to 90 mL/kg of crystalloids in the first hour (1 blood volume for the dog). Aggressive, but careful, fluid delivery, with frequent reassessment of the patient's status, is critical. Most MWDs can be resuscitated with much less than this calculated maximum volume.

   - For quick reference, ADD a ZERO to the dog's body weight (***in pounds***) to approximate a safe but effective bolus volume. For example, a 45# dog would need about a 450 mL bolus, and a 75# dog would need about 750 mL as a bolus.

3. Use synthetic colloids and hypertonic saline (HTS) in dogs with refractory shock. Very limited data in dogs suggest increased risks,[15-18] but dogs do not seem as sensitive to the adverse effects of these fluids as are people. Two recent studies in dogs showed no adverse side effects, specifically acute kidney injury, with tetrastarch use.[19,20] The benefits outweigh the risks, so be aggressive with synthetic colloid and HTS.[15-17]

   - Give hydroxyethyl starch (HES) as an IV or IO bolus of 10-20 mL/kg total over 5-10 minutes if clinical signs of shock do not abate after the first 30 minutes or the first 2 bolus crystalloid challenges), or response to crystalloid challenges is not sustained.[11-13,15,20,21] Repeat this bolus if no response to therapy.

   - Use HTS IV boluses, if 7.0 - 7.5% HTS is available, for MWDs that fail to respond to 2 or 3 boluses of crystalloids and/or 1 or 2 boluses of HES. Give 4 mL/kg over 5 minutes.[11-13,20] Do not administer HTS by the IO route.

Standard Shock Therapy (continued)

4. Human serum albumin (HSA) use. Do not give HSA or other synthetic colloids (e.g., dextrans) to MWDs, because severe allergic reactions are possible (HSA) and coagulopathies are common (dextrans). Some data suggest benefit in a very limited subset of patients with severe hypoalbuminemia,[22,23] but risks far outweigh potential benefit in dogs with shock.

5. Blood product use. Canine blood products are not available for immediate HCP use.[2] Dogs cannot be transfused with human blood products. HCPs will have to manage hemorrhagic shock with crystalloid and colloid therapy.

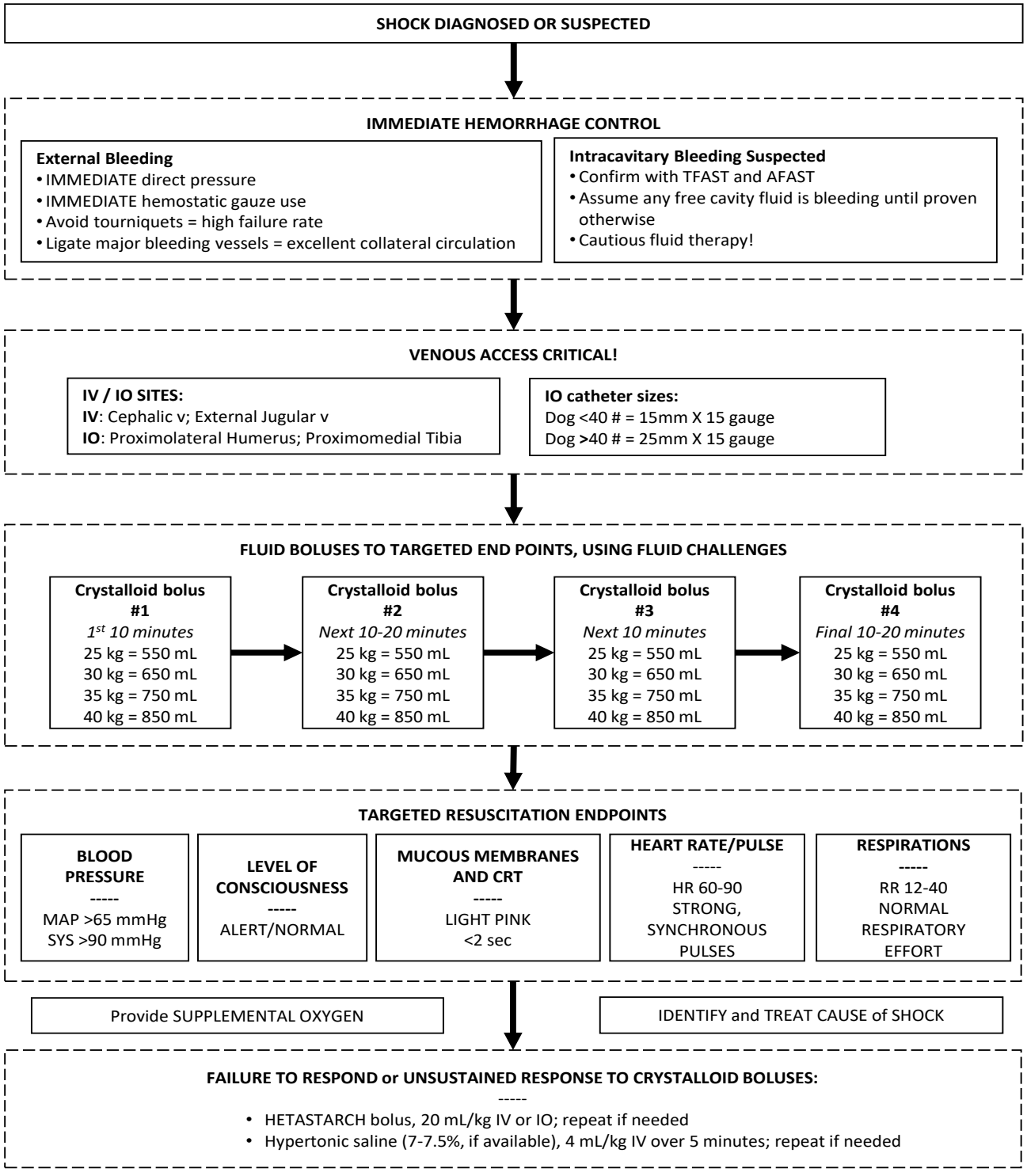
6. Tranexamic acid (TXA) and ε-aminocaproic acid (EACA) use. There is limited, but promising, data to guide use of TXA[24-27] and EACA[28] in dogs with hemorrhage. Dogs appear to be hyperfibrinolytic compared to humans, suggesting higher doses of TXA may be needed in dogs. Consider TXA or EACA if the dog is anticipated to need significant blood transfusion, such as severe hemorrhagic shock, limb amputation, penetrating torso trauma with severe non-compressible bleeding, because canine blood products are not available. Administer these drugs as soon as possible after trauma, but NO LATER THAN 3 HOURS post injury.
   - TXA: 10 mg/kg in 100 mL NS or LRS, IV over 15 min.
   - EACA: 150 mg/kg in 100 mL NS or LRS, IV over 15 min.
   - If bleeding continues, a CRI of additional TXA at 10 mg/kg/hour for 3 hours can be administered.

7. Targeted shock resuscitation end points that are practical for HCPs include systolic and mean arterial pressures, level of consciousness and mentation, mucous membrane color and capillary refill time, HR, RR, and pulse quality.
   - Target a MAP >65 mmHg or a Sys >90 mmHg. Note that neonatal or pediatric blood pressure cuffs must be used (See Chapter 2).
   - Target normal level of consciousness (LOC) and an alert mentation.
   - Target light pink-to-salmon pink MM and a CRT <2 seconds.
   - Target a HR that is 60-90 beats per minute at rest with a strong, synchronous pulse quality.
   - Target a respiratory rate at rest of 12-40 breaths per minute with normal effort.
   - Once shock has abated, continue IV crystalloid fluids at 3-5 mL/kg/hour for 12-24 hours to maintain adequate intravascular volume.

8. Provide supplemental oxygen therapy. Oxygen supplementation is critical. Every shock patient should receive supplemental oxygen therapy until stable (See Chapter 3).

9. Identify and treat the cause of shock. The cause of shock must be corrected, if possible.
   - Patients with massive intra-abdominal or intrathoracic bleeding need surgery to find the site of bleeding and surgically correct the loss of blood, with the caveats in mind as discussed previously.
   - Chapter 4 addresses emergent resuscitative thoracotomy. Chapter 7 addresses emergent abdominal laparotomy.
   - Euthanasia should be considered to prevent undue suffering for a MWD for which emergent surgery is deemed necessary but cannot be performed or has proven unsuccessful (See Chapter 21).

Figure 33. Clinical Management Algorithm for Shock Resuscitation in MWDs.


SHOCK DIAGNOSED OR SUSPECTED
IMMEDIATE HEMORRHAGE CONTROL
External Bleeding
• IMMEDIATE direct pressure
• IMMEDIATE hemostatic gauze use
• Avoid tourniquets = high failure rate
• Ligate major bleeding vessels = excellent collateral circulation
Intracavitary Bleeding Suspected
• Confirm with TFAST and AFAST
• Assume any free cavity fluid is bleeding until proven otherwise
• Cautious fluid therapy!
VENOUS ACCESS CRITICAL!
IV / IO SITES:
IV: Cephalic v; External Jugular v
IO: Proximolateral Humerus; Proximomedial Tibia
IO catheter sizes:
Dog <40 # = 15mm X 15 gauge
Dog >40 # = 25mm X 15 gauge
FLUID BOLUSES TO TARGETED END POINTS, USING FLUID CHALLENGES
Crystalloid bolus #1
1st 10 minutes
25 kg = 550 mL
30 kg = 650 mL
35 kg = 750 mL
40 kg = 850 mL
Crystalloid bolus #2
Next 10-20 minutes
25 kg = 550 mL
30 kg = 650 mL
35 kg = 750 mL
40 kg = 850 mL
Crystalloid bolus #3
Next 10 minutes
25 kg = 550 mL
30 kg = 650 mL
35 kg = 750 mL
40 kg = 850 mL
Crystalloid bolus #4
Final 10-20 minutes
25 kg = 550 mL
30 kg = 650 mL
35 kg = 750 mL
40 kg = 850 mL
TARGETED RESUSCITATION ENDPOINTS
BLOOD PRESSURE
MAP >65 mmHg
SYS >90 mmHg
LEVEL OF CONSCIOUSNESS
ALERT/NORMAL
MUCOUS MEMBRANES AND CRT
LIGHT PINK
<2 sec
HEART RATE/PULSE
HR 60-90
STRONG, SYNCHRONOUS PULSES
RESPIRATIONS
RR 12-40
NORMAL RESPIRATORY EFFORT
Provide SUPPLEMENTAL OXYGEN
IDENTIFY and TREAT CAUSE of SHOCK
FAILURE TO RESPOND or UNSUSTAINED RESPONSE TO CRYSTALLOID BOLUSES:
• HETASTARCH bolus, 20 mL/kg IV or IO; repeat if needed
• Hypertonic saline (7-7.5%, if available), 4 mL/kg IV over 5 minutes; repeat if needed

Figures 34-37. Intra-osseous Catheter Placement (Tibia) in a MWD.
Note: Sterile draping is removed to provide better visualization; perform catheterization using sterile technique.

Figure 34 shows the general landmark for IO catheterization on the upper medial aspect of the hind leg of the dog.

Figure 35 shows the intended insertion site (red oval) on the proximal medial tibial crest, just distal to the knee joint. The area should be clipped of hair and prepared for aseptic catheter placement.

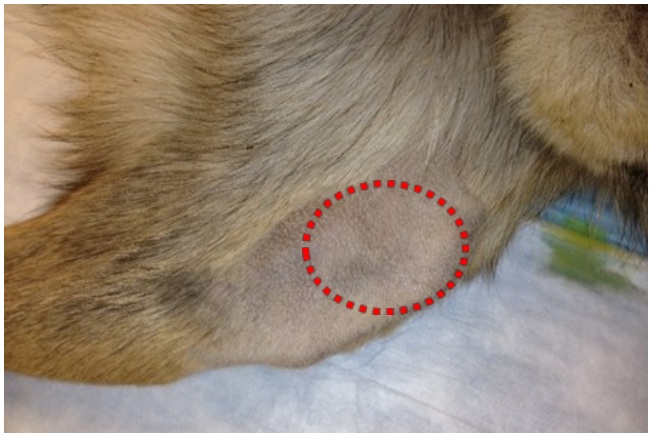


Figure 36 shows insertion of a pediatric IO catheter in the proximomedial tibia using the EZ-IO® device.

Figure 37 shows full insertion of the IO catheter, after removal of the stylet.

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Abdominal Trauma

Abdominal Injuries in Deployed MWDs

These injuries are the result of either blunt abdominal trauma (BAT) or penetrating abdominal trauma (PAT).[1-7] Management of these types of injuries differs markedly. Conservative medical management is usually indicated for MWDs with blunt abdominal trauma; whereas, urgent exploratory surgery is generally recommended for MWDs with penetrating injuries. A clinical management algorithm for MWDs with abdominal trauma is provided. (See Figure 38).

Physical Exam Finding Supporting Abdominal Trauma

Suspect significant intra-abdominal injury in any MWD that presents with abdominal rigidity or sensitivity to palpation, increasing abdominal size over time, visible bruising of the abdominal wall, or failure to respond to or deterioration in face of aggressive trauma resuscitation. Wounds involving more than the skin and superficial subcutaneous tissues dictate detailed examination to determine if the body wall was penetrated, and may require surgical exploration.

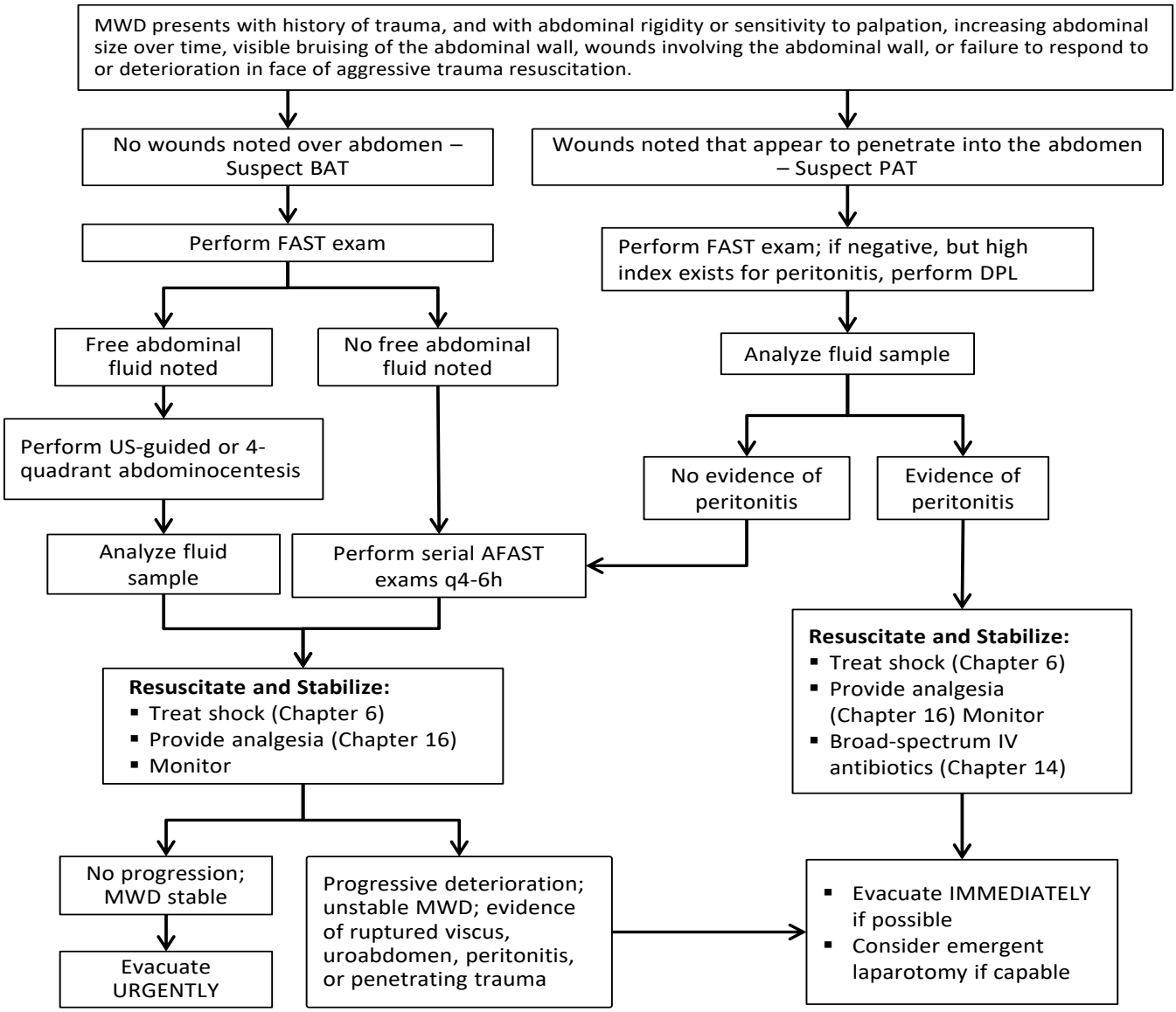
Diagnosis of Abdominal Trauma

The diagnostic method of choice for evaluating patients with suspected blunt abdominal trauma is the abdominal FAST (AFAST) exam, with ultrasound-guided or 4-quadrant needle abdominocentesis if free abdominal fluid is noted. Consider CT if advanced imaging is available.

Perform an AFAST exam during the initial evaluation phase of every MWD with a history of trauma, acute collapse, or weakness. FAST is proven in dogs to be extremely reliable in detecting free abdominal fluid and can be performed rapidly during resuscitation.[8]

- Examine 4 quadrants. Probe placement for dogs includes the diaphragmatic-hepatic site (DH) caudal to the liver, the splenorenal site (SR) around the left kidney, the cystocolic site (CC) cranial to the urinary bladder, and the hepatorenal site (HR) around the right kidney.[8] Figure 39 on page 51 provides a schematic showing probe placement in dogs. Fan the probe in the cranial-caudal and lateral-medial planes.

Figure 38. Clinical Management Algorithm for MWDs with Abdominal Trauma.


MWD presents with history of trauma, and with abdominal rigidity or sensitivity to palpation, increasing abdominal size over time, visible bruising of the abdominal wall, wounds involving the abdominal wall, or failure to respond to or deterioration in face of aggressive trauma resuscitation.
No wounds noted over abdomen – Suspect BAT
Wounds noted that appear to penetrate into the abdomen – Suspect PAT
Perform FAST exam
Perform FAST exam; if negative, but high index exists for peritonitis, perform DPL
Free abdominal fluid noted
No free abdominal fluid noted
Analyze fluid sample
Perform US-guided or 4-quadrant abdominocentesis
No evidence of peritonitis
Evidence of peritonitis
Analyze fluid sample
Perform serial AFAST exams q4-6h
Resuscitate and Stabilize:
Treat shock (Chapter 6)
Provide analgesia (Chapter 16) Monitor
Broad-spectrum IV antibiotics (Chapter 14)
Resuscitate and Stabilize:
Treat shock (Chapter 6)
Provide analgesia (Chapter 16)
Monitor
No progression; MWD stable
Progressive deterioration; unstable MWD; evidence of ruptured viscus, uroabdomen, peritonitis, or penetrating trauma
Evacuate IMMEDIATELY if possible
Consider emergent laparotomy if capable
Evacuate URGENTLY

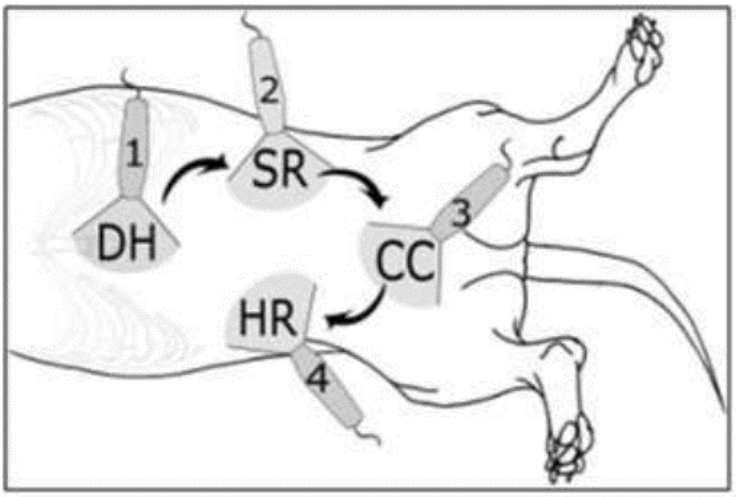


Figure 39. Imaging Locations for AFAST.

Figure 39 shows ultrasound probe placement sites for AFAST scanning of dogs. The dog's head is to the left; the dog is in right lateral recumbency.

DH = diaphragmatic-hepatic

SR = splenorenal

CC = cystocolic

HR = hepatorenal

- Score the AFAST exam, with 1 point for each quadrant that has free fluid identified. Perform serial FAST exams every 4-6 hours and compare scores. MWDs with increasing scores should be monitored closely and prepared for URGENT evacuation or surgery, as exploratory surgery may be necessary for MWDs with scores of 3/4 or 4/4[8] or with clinical deterioration.

Perform a 4-quadrant abdominocentesis in any patient with free fluid in the abdomen.[9] This technique is quick and easy to perform, and usually differentiates abdominal hemorrhage or biliary or urinary tract injury. The general rule of thumb is that a positive peritoneal tap is a reliable indicator that some hemorrhage has occurred or that free urine or bile is in the abdominal cavity, but that a negative tap does not rule these out.

- Place the dog in lateral recumbency. Clip the abdomen of hair and prepare for aseptic procedure.
- "Divide" the abdomen into 4 quadrants, and tap each quadrant sequentially, unless a positive yield is obtained in a quadrant. Perform abdominocentesis on the "down" quadrants, rolling the dog over for the opposite quadrants.
- A large bore needle (18 or 20 gauge) is quickly inserted perpendicular to and through the body wall approximately 2 inches off the midline in each quadrant. Alternatively, a large bore over-the-needle catheter can be aseptically fenestrated and inserted into the abdomen. This increases the likelihood for higher yield because the fenestrations are less likely to occlude.
- The presence of blood suggests intra-abdominal hemorrhage, and the presence of clear or yellowish fluid suggests urine.
- As much sample is collected by gravity drip or slight suction with a 3 cc syringe and saved in serum tubes and EDTA tube. The fluid is analyzed cytologically, and for glucose, lactate, hematocrit, total protein concentration, BUN or creatinine, bilirubin, amylase or lipase, ALT, and ALKP.
  - Assess cytology for the presence of bacteria or other organisms, or fecal or food material that would suggest gastrointestinal rupture and contamination.
  - The peritoneal fluid glucose and lactate concentrations can be measured and compared to serum levels to aid in differentiating possible septic peritonitis in the absence of cytological evidence. An increased abdominal fluid lactate >2.5 mmol/L or an abdominal fluid-to-peripheral blood lactate

difference of >2 mmol/L strongly suggests a septic peritonitis.[10,11] An abdominal fluid glucose concentration that is >20 mg/dL lower than peripheral blood glucose concentration strongly suggests a septic peritonitis.[10,11]

- The hematocrit and total protein concentration are compared to a simultaneously collected peripheral blood sample. If the hematocrit and total protein concentration are similar, significant hemorrhage into the abdomen is probable, and surgical intervention may be necessary, but base this decision on the patient's status more than the actual number. If the hematocrit and total protein concentration of the abdominal fluid are very low, minor hemorrhage is more likely, and a more conservative approach – based on the patient's status – is recommended.

- The presence of bilirubin suggests gall bladder injury, although this may not be present for several days after trauma.[9] Amylase or lipase with values higher than systemic circulation suggests pancreatic trauma. A ratio of 1.4:1 in comparing abdominal fluid potassium with peripheral blood potassium concentrations has 100% sensitivity and specificity for uroperitoneum.[12] Comparison of abdominal fluid creatinine to peripheral blood creatinine concentrations shows 86% sensitivity and 100% specificity for ratios >2:1.[12] Elevated ALT suggests direct liver injury, and elevated ALKP suggests bowel injury or ischemia, but these are non-specific and can rarely be used to guide management decisions.

Consider diagnostic peritoneal lavage (DPL) in any MWD in which major abdominal trauma is suspected, but AFAST and abdominocentesis are unrewarding.[9] If available, CT or MRI may be better modalities.

- Use a specialized DPL catheter or aseptically fenestrate a large bore over-the-needle (OTN) catheter.
- Sedate the patient if necessary and locally anesthetize the site of catheter insertion using 20 mg lidocaine.
- Percutaneously insert the catheter; a small stab incision may be needed if a larger catheter is used.
- Immediately after entering the abdominal cavity, remove the needle and advance the catheter in a caudodorsal direction to avoid the omentum and cranial abdominal organs.
- Infuse 20 mL/kg warmed, sterile saline aseptically over 5-10 minutes.
- Aseptically plug the catheter and gently roll the MWD from side to side for several minutes to allow the infusate to mix.
- Either aspirate effluent or allow gravity-dependent drainage to collect a sample for analysis.
- Analyze the sample for the same parameters described for abdominocentesis.

Blunt Abdominal Trauma (BAT)

The usual organs in MWDs subjected to blunt trauma are the spleen, liver, and urinary bladder, in this order of frequency. Splenic and hepatic injuries are usually fractures of the organ; major vessel trauma is uncommon.[1-7]

- Intra-abdominal hemorrhage. Most hemoperitoneum cases in MWDs are due to splenic and hepatic frac-

tures, which can vary markedly in size, with a significant difference in quantity of blood lost into the abdomen.

- The majority of MWDs with BAT and intra-abdominal hemorrhage that survive to admission can be successfully managed conservatively, since most of the time the source of hemorrhage is small liver and splenic fractures. These usually will spontaneously cease bleeding given time and conservative fluid therapy. Monitor the MWD closely, as some will require exploratory laparotomy and surgical correction of hemorrhage, especially those that do not respond or deteriorate.
- Given the difficulty in maintaining an abdominal counterpressure bandage, and the risk of respiratory compromise, do not apply an abdominal counterpressure bandage on a MWD.
- Patients with massive intra-abdominal bleeding need surgery to find the site of bleeding and surgically correct the loss of blood. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance.

- Urinary tract trauma. Urinary bladder rupture, with uroperitoneum, is fairly common, especially if the animal had not voided before the trauma.
  - MWDs with acute urologic trauma and uroperitoneum should be stabilized for other injuries, and aggressively managed for shock. Primary repair of a ruptured urinary bladder or other urologic injury must wait until the patient stabilizes to minimize the risk of complications associated with taking an unstable patient to surgery.
  - In many cases, urologic injury is not apparent for several days after trauma, so a high index of suspicion must be maintained. Special studies (ultrasound, excretory urography, contrast urethrocystography) may need to be performed to rule out urologic trauma.
  - In patients with known urologic tears and urine leakage, abdominal drains may be indicated if surgery is delayed for several days while the patient stabilizes. This will allow removal of urine, which will minimize chemical peritonitis and electrolyte and acid-base imbalances (metabolic acidosis, hyperkalemia). Intensive fluid therapy to correct or prevent electrolyte and acid-base imbalances is often necessary, especially if several days have passed since traumatic injury.
  - Surgical repair must only be performed after the patient is stabilized. Patients with severe uroabdomen need surgery to define the extent of injury and correct the problem. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter.
- Ruptured abdominal viscus. Patients with a ruptured gastrointestinal viscus are candidates for emergent exploratory surgery to identify the part of the tract that is injured and allow primary repair. Delay in repairing bowel perforation can rapidly lead to septic peritonitis, septic shock, and rapid patient deterioration.[13]

TABLE 11. ANTIBIOTIC SELECTION AND DOSING FOR MWDS			
ANTIBIOTIC	**DOSE FOR MWD**	**ROUTE**	**FREQUENCY**
Amoxicillin-Clavulanic Acid	13.75 mg/kg	PO	q 12 h
Ampicillin Sulbactam	20 – 30 mg/kg	IV q	8 h
Cefazolin	20 -30 mg/kg	IV q	8 h
Cefotaxime	22 mg/kg	IV q	8 h
Ceftriaxone	25 mg/kg	IV q	8-12 h
Cephalexin	20 – 30 mg/kg	PO q	12 h

- Broad-spectrum antibiotic therapy is vital, especially against anaerobic and gram negative bacteria. Table 11 lists antibiotic options for initial use in MWDs with ruptured viscus or septic peritonitis.
- Shock management is of special importance. Every attempt must be made to stabilize the patient as much as possible, with URGENT evacuation to a veterinary facility for definitive repair.
- Patients with ruptured abdominal viscus need surgery to define the extent of injury and correct the problem. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance.

Penetrating Abdominal Trauma

Exploratory laparotomy as a diagnostic and therapeutic modality is clearly indicated in trauma patients if penetrating trauma is highly suspected or known, or if the patient's status deteriorates despite aggressive resuscitation attempts and major organ hemorrhage or injury is suspected or known.[13]

- Non-invasive diagnostic imaging is recommended in an attempt to confirm a suspicion of major internal organ injury. Perform AFAST, abdominocentesis, and/or DPL as necessary, and advanced imaging if available.
- Patients with penetrating abdominal injuries and a high index of suspicion for peritonitis, bowel injury, ruptured viscus, major hemorrhage, or other life-threatening problem need emergent surgery to further define the extent of injury and provide corrective surgery. There may be instances in which emergent laparatomy is necessary by HCPs to afford a chance at patient survival. See **Emergent Abdominal Laparotomy** in this chapter for guidance. Empiric antibiotic therapy is critical (See Table 11).

Emergent Abdominal Laparotomy

Some patients with severe abdominal trauma require surgery to define the extent of injury and attempt repair of the problem, remembering the caveats discussed previously.[13]

- Surgical management includes an approach through the ventral midline under general anesthesia with the dog in dorsal recumbency, to expose the abdominal cavity.

- A complete abdominal exploratory is necessary to define all injuries. Routine exploratory techniques used for people are appropriate for dogs.
- Surgical management will depend on the injuries noted. Expect hemoabdomen, liver and spleen trauma with hemorrhage, major vessel injuries with hemorrhage, bowel perforation, hollow viscus injuries, urinary tract injuries, and abdominal wall injuries. Repair of injuries in the dog is essentially the same as repair in human casualties.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Abdominal Trauma References

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CHAPTER 8

Gastrointestinal Emergencies

Among other gastrointestinal emergencies, MWDs are at increased risk for development of two life-threatening gastrointestinal emergencies: Gastric Dilatation-Volvulus Syndrome, and mesenteric volvulus.[1-3]

Gastric Dilation-Volvulus Syndrome (GDV or "bloat")

GDV is a multifactorial, rapidly progressing, life-threatening surgical emergency common in large-breed dogs, to include MWDs.[4] In GDV, the stomach rapidly dilates (gastric dilation) with fluid, food, and air, and then rotates along the long axis (volvulus). When volvulus develops, the esophagus and duodenum become twisted, preventing passage of stomach contents. The amount of air, food, and fluid that accumulates is dramatic and progressively worsens – typically over 30 minutes to 4 hours – and causes shock by interfering with venous return from the abdomen and pelvic limbs. Death in cases of GDV in the short-term is due to shock. Death in the long-term is due to gastric wall necrosis and rupture with secondary sepsis, DIC, or cardiac arrhythmias.[4-5]

Most MWDs have had a prophylactic gastropexy performed before deployment. This elective surgical procedure creates a surgical adhesion between the stomach and the inner abdominal wall that is very effective at preventing volvulus. While gastric dilation (GD) can still occur, this in and of itself is seldom severe enough to cause shock, since accumulated gas and stomach contents can be vomited or passed into the bowel. However, HCPs should recognize that many deployed working dogs operated by Allied military forces and DoD contractors likely have not been gastropexied, and – in rare cases – a gastropexy can fail, and GDV must be a differential in dogs with typical signs.

Clinical Signs of GDV

GDV patients classically present with a constellation of clinical signs that should prompt immediate evaluation. MWD handlers are trained to recognize these signs, and handlers may have performed emergency care before the dog is presented to a MTF, to include gastric decompression.

Early signs of GDV include varying degrees of abdominal distention (tympany) from stomach filling with air, food, and fluid; nonproductive retching, attempted vomiting without result, or retching a small amount of saliva ("dry heaves"); signs of pain (grunting, especially when the stomach or abdomen is palpated); signs of anxiety, which is commonly noted as pacing, anxious stares, and inability to get comfortable when lying down; and signs of compensatory shock (tachycardia, tachypnea).

As GDV progresses, clinical signs of advancing shock ensue. MWDs may present at any time in the continuum of the syndrome, and often present *in extremis* if recognition or care has been delayed.

HCPs should assume GDV is present and take immediate action if an MWD presents with signs of shock, abdominal distension, non-productive vomiting or retching, and signs of anxiety or pain.

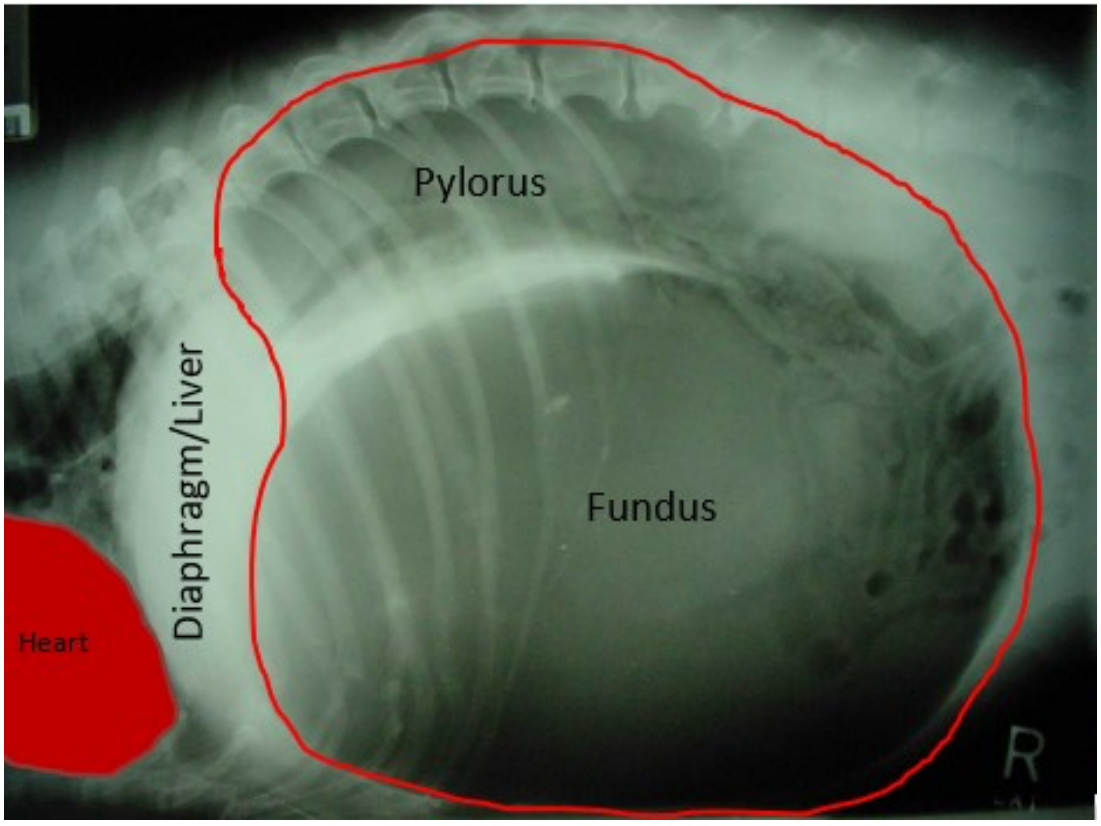
Definitive Diagnosis of GDV

Confirmation of GDV is based on abdominal radiographs that demonstrate marked gastric dilation with air (See Figure 40). Radiography, if available, is recommended if there is doubt about the diagnosis, as other conditions (e.g., hemoperitoneum, abdominal neoplasia, ascites) mimic some of the signs of GDV. Generally, a single right lateral radiograph is sufficient.

Management of GDV

A management algorithm is provided (See Figure 41). The hallmark immediate treatment of GDV includes rapid decompression of gas from the dilated stomach, shock therapy, monitoring for complications, repeated decompression if dilation recurs, and rapid evacuation to veterinary facilities for definitive surgery. GDV is a surgical emergency; surgery is required to derotate the stomach and perform gastropexy, and to perform partial gastric resection or splenectomy if warranted, with extended monitoring for common life-threatening sequellae in the post-operative period.

Figure 40. Radiograph with Gastric Dilation Volvulus.
Figure 40 shows a right lateral radiograph of a dog with marked gastric dilation due to GDV. Head is to left. Red line depicts general outline of the massively distended stomach, with the pylorus malpositioned dorsal to the fundus.



GDV Management Summary

- **Treat shock.** Provide 100% oxygen (See Chapter 4). Administer intravenous fluids to targeted end-points (See Chapter 6, Figure 33).
- **Decompress the stomach by percutaneous trocarization of the stomach:**
- Position yourself on the left side of the patient, or lay the dog with its left side down (left lateral recumbency).
- **Locate the insertion point:**
  - Palpate the last rib.
  - Move the hand 2 inches caudal to the last rib, midway between the spine and the ventral border of the abdomen on the right side.
  - Auscult the lateral abdominal wall at the most distended area while percussing (flicking) the abdominal wall firmly with a finger. This percussion will elicit a "pinging" sound, and the site of insertion of the trocar should be at the point of loudest "pinging."
- Clip the hair over a 6-inch X 6-inch area over this area. Prepare the area using surgical scrub.
- Forcefully insert a 10-14 gauge trocar or 14-18 gauge IV over-the-needle catheter through the skin, abdominal wall, and stomach wall. Note gas or air escaping through the trocar/needle from the stomach to signify a successful trocarization.
- Note: If no air or gas is coming from the trocar, attempt gastric trocarization one more time. If still unsuccessful, do not attempt any further trocarizations. Emergent surgery is indicated if trocarisation is not possible.
- Gently apply external pressure to the abdominal wall to assist in decompressing air from the stomach.
- Once the majority of the air is evacuated, remove the trocar/needle, because leaving it inserted may cause trauma to internal organs.

Common Complications Associated with GDV

Monitor for the most common complications seen in MWDs with GDV, to include ventricular arrhythmias, persistent shock, recurrent gastric dilation, nausea and vomiting, ileus, electrolyte abnormalities (especially potassium), and metabolic acidosis. Multi-organ failure may develop, depending on the degree and duration of shock.

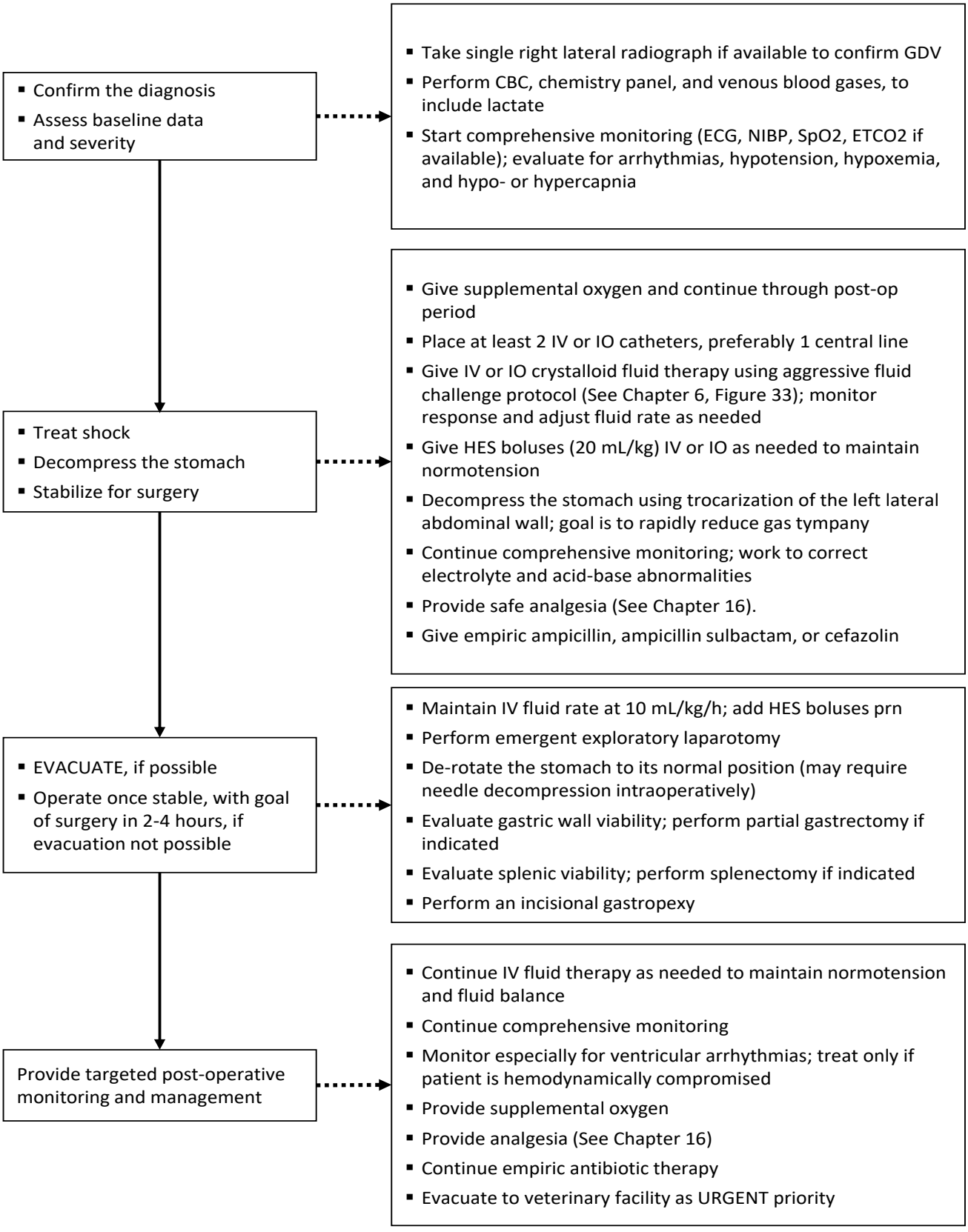
Definitive Surgical Management of GDV

Evacuate the MWD to a veterinary facility as soon as it is stabilized. Any MWD with GDV should be considered an URGENT casualty. Definitive surgical management – consisting of exploratory laparotomy, derotation of the stomach, gastropexy, and possible partial gastric resection and/or splenectomy – requires trained personnel intimate with the anatomy and physiology of the dog.

Emergency surgical exploration of the abdomen and attempted surgical management of GDV by HCPs in the deployed setting may be necessary if evacuation will be delayed more than 4-6 hours.

- It is essential to counter shock and stabilize the dog before considering operative management.
- Surgical management includes an approach through the ventral midline under general anesthesia, with the dog in dorsal recumbency, to expose the abdominal cavity (See Chapter 16.)
- GDV is confirmed once the abdomen is open by identifying a dilated stomach covered by omentum.
- The stomach is de-rotated to its normal position by grasping the stomach on both extreme lateral aspects simultaneously, and rotating the stomach counterclockwise (when viewed from the dog's right side in dorsal recumbency).
- A markedly tympanic stomach may need to be further decompressed by intraoperative needle decompression with suction to allow adequate manipulation.
- Typically, the gastric wall has variable degrees of bruising, especially at the cardia, and may have developed partial- or full-thickness necrosis. If bruising persists or worsens intraoperatively, or if gastric wall necrosis is suspected, perform a partial gastrectomy of suspect gastric wall. Gastrectomy is ideally performed using TA or GIA surgical stapling equipment or an inverting double-layer gastric wall suture pattern of non-absorbable suture. Note that postoperative mortality in dogs that require gastrectomy is approximately 25 -35%, compared to mortality <10% in dogs that do not require gastrectomy.
- Typically, intra-abdominal bleeding is encountered due to rupture of the short gastric arteries and/or splenic injury. Assess the viability of the spleen and perform splenectomy if splenic thrombosis, marked splenic vessel injury and bleeding, or splenic lacerations are noted. Arcade ligation, with special attention to the major splenic vessels, is optimal, and is best done with LDS stapling equipment (for vessels <4 mm diameter) and suture ligation (for vessels >4 mm diameter) using transfixation sutures.
- Perform an incisional gastropexy (to prevent future GDV). Create a 3-4 cm incision in the seromuscular layer of the right pyloric area of the stomach wall. Create a similarly-sized incision in the right ventrolateral abdominal wall musculature. Appose the margins of the gastric wall incision against the margins of the incision in the abdominal wall musculature and create a gastropexy by suturing each margin using 0 or 2-0 non-absorbable suture.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Figure 41. Clinical Management Algorithm for Gastric Dilatation-Volvulus (GDV) in Military Working Dogs.


Confirm the diagnosis
Assess baseline data and severity
Take single right lateral radiograph if available to confirm GDV
Perform CBC, chemistry panel, and venous blood gases, to include lactate
Start comprehensive monitoring (ECG, NIBP, SpO2, ETCO2 if available); evaluate for arrhythmias, hypotension, hypoxemia, and hypo- or hypercapnia
Treat shock
Decompress the stomach
Stabilize for surgery
Give supplemental oxygen and continue through post-op period
Place at least 2 IV or IO catheters, preferably 1 central line
Give IV or IO crystalloid fluid therapy using aggressive fluid challenge protocol (See Chapter 6, Figure 33); monitor response and adjust fluid rate as needed
Give HES boluses (20 mL/kg) IV or IO as needed to maintain normotension
Decompress the stomach using trocarization of the left lateral abdominal wall; goal is to rapidly reduce gas tympany
Continue comprehensive monitoring; work to correct electrolyte and acid-base abnormalities
Provide safe analgesia (See Chapter 16).
Give empiric ampicillin, ampicillin sulbactam, or cefazolin
EVACUATE, if possible
Operate once stable, with goal of surgery in 2-4 hours, if evacuation not possible
Maintain IV fluid rate at 10 mL/kg/h; add HES boluses prn
Perform emergent exploratory laparotomy
De-rotate the stomach to its normal position (may require needle decompression intraoperatively)
Evaluate gastric wall viability; perform partial gastrectomy if indicated
Evaluate splenic viability; perform splenectomy if indicated
Perform an incisional gastropexy
Provide targeted post-operative monitoring and management
Continue IV fluid therapy as needed to maintain normotension and fluid balance
Continue comprehensive monitoring
Monitor especially for ventricular arrhythmias; treat only if patient is hemodynamically compromised
Provide supplemental oxygen
Provide analgesia (See Chapter 16)
Continue empiric antibiotic therapy
Evacuate to veterinary facility as URGENT priority

Mesenteric Volvulus

Mesenteric volvulus (MV) is a rapidly progressive and often fatal condition in which intestinal rotation develops around the root of the mesentery. Although rare, it appears to be increasing in frequency in MWDs.[3] The case fatality rate was 92% in a recent report of 54 MWDs with MV; of these 24% were found dead and 76% were identified antemortem, and only 14% of the 126 reported cases have survived.[3] Rapid recognition is necessary to afford MWDs a chance at survival.

- In MV, the cranial mesenteric blood vessels and branches obstruct due to rotation, causing ischemic necrosis of the aborad duodenum, all the jejunum, ileum and cecum, ascending and transverse colon, and orad descending colon.
- Death is due to rapidly progressive vascular obstruction, intestinal anoxia, shock, endotoxemia, and cardiovascular failure.[3]
- Statistical analysis of MV in 54 MWDs[3] suggests key risk factors include German shepherd breed, age, prophylactic gastropexy or other abdominal surgery, history of gastrointestinal disease, use of nonsteroidal anti-inflammatory drugs, and increased humidity on the day of occurrence.

Clinical Signs and Imaging Findings Suggesting MV

- Peracute-to-acute onset of vomiting, mild abdominal distension, and shock.
- Hemorrhagic diarrhea with or without tenesmus.
- Intense abdominal pain on palpation.
- Rapidly progressive deterioration in clinical presentation.
- Extreme gas distension of the majority of the small and large bowel (See Figure 42 below).

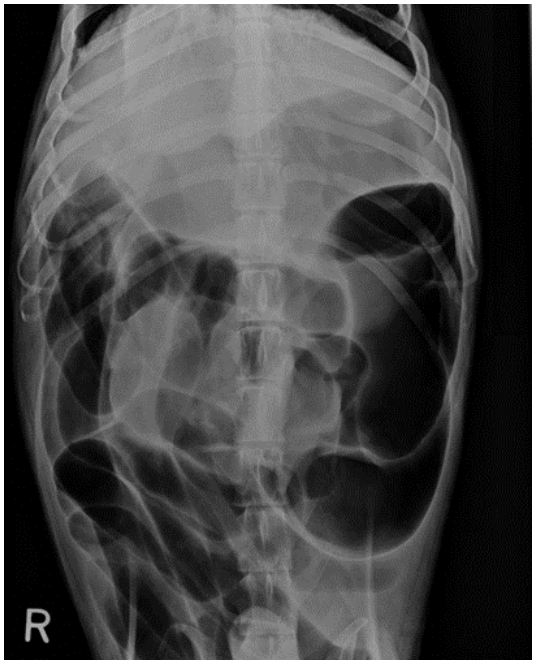
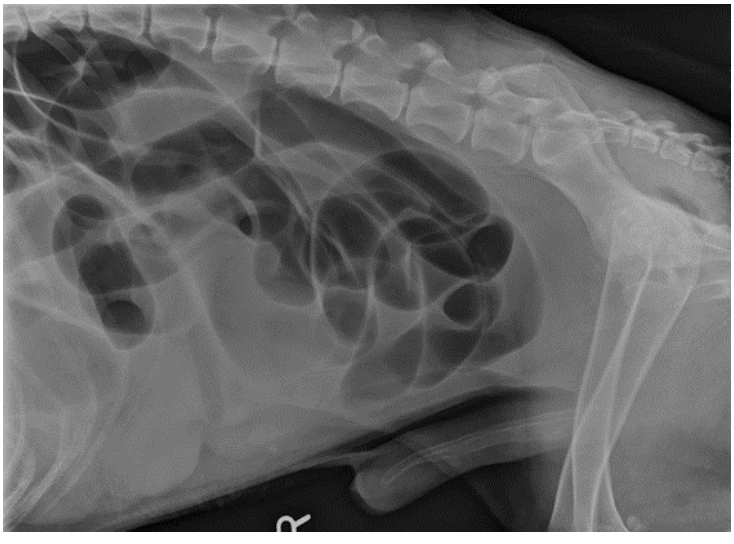


Figure 42. Lateral and ventrodorsal abdominal radiographs of a dog with MV, demonstrating near complete and severe gas distension of the entire bowel.



Emergent Management of MV

MV is a true surgical emergency. The hallmark immediate treatment of MV includes rapid assessment and determination of the need for emergent abdominal surgery, and aggressive shock therapy – err on the side of emergent abdominal laparotomy if clinical signs and imaging suggest MV. It is unlikely the dog can be evacuated soon enough to veterinary facilities, so be prepared to operate in the MTF. Extended monitoring for common life-threatening sequellae is required in the post-operative period.

Treat shock:

- Provide 100% oxygen (See Chapter 4).
- Administer intravenous fluids to targeted endpoints (See Chapter 6, Figure 33).

Perform emergent exploratory laparotomy:

- It is essential to begin to counter shock as you prepare for surgery.
- Surgical goals are to confirm the diagnosis, determine surgical options, and assess prognosis.
- Surgical management includes an approach through the ventral midline under general anesthesia (See Chapter 16), with the dog in dorsal recumbency, to expose the abdominal cavity.
- Operative management by resection and anastomosis should only be considered if the following conditions are met:
  - The duodenum is intact in its entirety;
  - At least 2cm of healthy ileum is present;
  - At least 50% of the jejunum is assessed to be viable;
  - No large bowel is affected.
- Abdominal wall closure is in 3 layers: 0 non-absorbable simple interrupted linea alba closure; 2-0 absorbable simple continuous subcutaneous closure; routine skin closure.

Euthanasia should be considered for an MWD presenting in extremis, or in dogs that fail to respond to therapy, that deteriorate despite care, or in which operative management is not feasible (See Chapter 21).

Common Complications Associated with MV

Monitor for the most common complications seen in MWDs with MV, to include ventricular arrhythmias, persistent shock, septic peritonitis, nausea and vomiting, ileus, and metabolic acidosis. Multi-organ failure may develop, depending on the degree and duration of shock.

Gastrointestinal Emergencies References

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CHAPTER 9

Heat Injury

Heat loss in dogs is via convection, conduction, and evaporative loss, contrasted to radiant heat loss of humans.[1] Panting is the only significant cooling mechanism for dogs. A recent study[2] in exercising MWDs demonstrates that temperatures up to 106^0 F are not uncommon in healthy MWDs during work, and that body temperature continues to increase over the course of 15 minutes after exercise; dogs not affected with heat injury rapidly normalized their temperatures within 15-20 minutes.

In MWDs, heat-induced injury usually develops due to heavy exertion in environments with high temperatures, compounded by high humidity and/or inadequate acclimation. Rarely, MWDs may develop heat-induced injury if left in or trapped in closed vehicles or containers in high-heat environment, or due to partial airway obstruction of any cause. The subsequent hyperthermia exceeds the capability of the MWD to compensate.

There are three types of heat-induced injury in veterinary patients, based on the severity of the resulting injury: mild ("heat stress"), moderate ("heat exhaustion"), or severe ("heat stroke"). Severe heat injury is associated with a mortality rate of 50-64%.[3-5]

Mild Heat Injury[6-9]

- Mild heat injury is characterized clinically by development of excessive thirst, discomfort associated with physical activity, but with controlled panting (i.e., the patient can control or reduce panting when exposed to a noxious inhalant such as alcohol).
- Treatment of mild heat injury involves removing the patient from the source of heat, stopping exercise, cooling by use of fans or movement to an air-conditioned area, and offering cold water for the dog to drink.
- Close monitoring for several hours is necessary to ensure heat stress does not progress, or rebound hypothermia does not develop.
- Key parameters to monitor, in addition to frequent body temperature measurement, include changes in mentation, development of petecchiae or ecchymoses, hematuria, weakness or collapse, clinical signs of shock (e.g., tachypnea, tachycardia, weak pulse quality, pale mucous membranes), and anxiety or restlessness.

Moderate Heat Injury[6-9]

- Moderate heat injury is present when the signs of heat stress are present, as well as weakness, anxiety, and uncontrolled panting (i.e., the patient cannot reduce or stop panting when exposed to a noxious inhalant), but CNS abnormalities are not present.
- Treatment of moderate heat injury is the same as for heat stress, but more aggressive measures at cooling are often necessary.
- The patient must be removed from the source of heat and all activity must be stopped.
- Cooling by use of fans or movement to an air-conditioned area should be done if possible. The hallmark treatment for moderate and severe heat injuries is to thoroughly soak the hair coat to the skin with tepid water to reduce core body temperature.
- Close monitoring for several hours as stated for heat stress is necessary to ensure heat exhaustion does not progress, or rebound hypothermia does not develop.

Severe Heat Injury[3-9]

- Severe heat injury is present when signs of heat exhaustion are present, coupled with varying degrees of central nervous system (CNS) abnormalities (encephalopathy). The most common CNS abnormalities include changes in mentation and level of consciousness (e.g., obtunded, stupor, coma), seizures, abnormal pupil size, cortical blindness, head tremors, and ataxia. Heat stroke is a life-threatening condition.
- It is characterized by a severe increase in core temperature and widespread, multiple organ injury with risk of progression to multi-organ failure.
- No specific body temperature defines heat stroke in MWDs; however, temperatures as low as 105.8°F have been associated with pathology. Most commonly, heat stroke is seen in MWDs with rectal temperatures >107°. Studies report multiple serious complications and high fatality rates in heat stroke patients despite proper treatment.[3-5] Table 12 describes the management of MWDs with heat-induced injury.

Initial Management Considerations for Heat-injured MWDs[7,10]

- Triage of the MWD with heat injury is similar for other types of injury or illness, but with emphasis on assessing mentation, airway and breathing, circulation, and body temperature. MWDs typically present with obtundation or stupor; however, heat stroke patients can be alert and responsive, stuporous, or comatose. MWDs presenting in stupor or coma are in imminent danger of death. Some heat stroke patients present actively seizuring.
- Anticipate that in a state of hyperthermia, the patient's initial physiological response will be to move blood to the surface vessels to maximize conductive cooling. The initial phase will generally include renal and

splanchnic vasoconstriction, peripheral vasodilatation, and increased cardiac output. Over time, if the body temperature remains high, splanchnic and renal vasoconstriction will eventually fail, creating conditions favorable for venous pooling and hypovolemia or distributive shock. Monitor continuous ECG, blood pressure, mucus membrane color, and capillary refill time.

- Rectal temperature may lag behind core body temperature by up to 15 minutes.[3] Heat stroke patients may therefore be hypothermic, hyperthermic, or normothermic upon presentation, based on cooling measures initiated by the handler and length of time since onset of heat stroke.

Emergency Management of Heat Injury[7,10,11]

- Intubate MWDs if apneic or not breathing adequately; maintain IPPV at 8-12 breaths/minute. Protect the airway if intubated while cooling with water, to reduce chances of aspiration of running water. Provide supplemental oxygen until normoxemia is confirmed with the MWD breathing room air. Use "blow by" technique if not intubated (See Chapter 3), as oxygen masks can increase humidity and prevent maximal heat dissipation.

- MWDs with a rectal temperature > 105° F require emergency cooling measures. Use a combination of cooling methods! The rate of cooling should be as rapidly as possible until the body temperature is 105° F. The most practical, most expedient, and most rapid method to reduce body temperature is to soak the patient thoroughly to the skin with room-temperature water. The patient can be placed under running tepid water in a well-drained tub or submerged partially in a tub of tepid water. The key is to soak the entire MWD as rapidly as possible, and to soak through the hair coat to soak the skin thoroughly.

- The value of intravenous fluids in patient cooling and support cannot be overstated. Unless there are specific contraindications, intravenous fluid therapy using room-temperature fluids should be initiated for any MWD with heat stroke. Adequate circulating blood and plasma volume are required for conduction to maximize heat dissipation, and IV room-temperature fluids reduces core body temperature.

- Use additional cooling methods! Direct fans on the MWD to facilitate surface cooling. If possible, move MWD to a cool room or reduce the ambient temperature of the treatment room.

- Use of cold intravenous fluids, ice-water baths, and surface cooling with ice water or ice packs are contraindicated because they cause peripheral vasoconstriction with sustained increase in core temperature, cause shivering which generates more internal heat, and promote capillary sludging which contributes to coagulopathy. Placing isopropyl alcohol on the footpads is commonly done, but is ineffective because the paw pads have such a small surface area.

- Once the patient's body temperature is <105°, the rate of cooling can be reduced to avoid rebound hypothermia. Discontinue ancillary cooling measures (e.g., remove fans, return room temperature to normal), and dry the MWD's skin.

- Once the MWD's body temperature is <103°, provide supportive warming, cease all cooling efforts, monitor temperature continuously, and be prepared to actively warm the patient to prevent an excessive drop in body temperature (rebound hypothermia). Although warming a patient with a temperature of 103° F may

seem counterintuitive, HCPs should anticipate a period of rebound hypothermia, and understand that the delay between rectal temperature and true core temperature likely means that the true core temperature may be lower.

- HCPs should evacuate any MWD heat stroke casualty to veterinary facilities on an URGENT basis if feasible.

Monitor and Treat Concurrent or Developing Problems[7,10,11]

- Shock is common in MWDs with heat stroke. Manage shock (See Chapter 6, Figure 33). Monitor blood pressure, lactate clearance, clinical assessment of perfusion, and assessment of volume status until the MWD is evacuated.

- Glucose, acid-base, and electrolyte abnormalities are common. If able, monitor blood glucose and venous blood gas analyses every 6-12 hours. If concurrent pulmonary abnormalities are present, monitor arterial blood gas analysis (or surrogates such as pulse oximetry and capnography). Supplement maintenaced IV fluids with dextrose to 5% and with KCl at 20 mEq/L routinely to maintain normoglycemia and normokalemia.

- Hypercoagulable and consumptive coagulopathic states (e.g., DIC) are common. Gastrointestinal hemorrhage is common during recovery, and may be present on admission. FFP or canine serum albumin may be necessary; however, these are not available to HCPs, and HCPs must not give human FFP or human serum albumin to dogs. Coagulation testing for MWDs will be problematic for HCPs, as analyzers for human blood will not provide accurate results for canine blood. HCPs should monitor the MWD and CBCs (if available) for evidence of thrombocytopenia (petecchiae, ecchymoses, low platelet count). HCPs should monitor for signs of clotting abnormalities (e.g., hematoma formation, intracavitary bleeding, epistaxis, hematuria). MWDs rarely require whole blood or pRBCs to treat complications of heat-induced illness; frozen plasma or fresh frozen plasma may be necessary in severe cases. HCPs must never give human blood to dogs. URGENT evacuation to veterinary facilities is critical to survival of MWDs that develop bleeding disorders, as veterinary personnel can facilitate canine blood product collection and administration.

- Cardiac arrhythmias, especially ventricular arrhythmias, are common, but rarely require intervention. Perform continuous or intermittent ECG monitoring. Treat ventricular arrhythmias only if causing hemodynamic compromise, using lidocaine (2 mg/kg IV bolus, then 50-75 mcg/kg/min CRI).

- Vomiting and diarrhea are typical. Diarrhea is often hemorrhagic. Start systemic antibiotic therapy (See Chapter 14) for any MWD with hemorrhagic diarrhea. Start famotidine therapy (1 mg/kg IV, IM, or PO q12h) for any MWD with heat stroke. Treat nausea and vomiting with ondansetron (1 mg/kg, IV or PO, q12-24h). Add sucralfate (1 gram PO q8h) for any MWD with hematemesis. Allow food and water once vomiting has resolved. Hygiene is critical, and bedding should be changed as needed; shave long tail hair and wrap tails to minimize soiling.

- Renal insufficiency is uncommon, but possible. Maintain urine production at 1-2 ml/kg/hour. Monitoring urine output in males will be difficult without canine-specific urethral catheters; use estimates of voiding or weigh absorbent pads or blankets to estimate urine output. Alternatively, in male dogs, adapt a 10- or 12-Fr

suction catheter (ubiquitous in trauma bays) by removing the control valve end, aseptically inserting the remaining catheter into the urethra to the level of the urinary bladder, and connecting the distal end to a sterile empty IV bag or closed collection system by way of an adapter.

- Treat seizures with a benzodiazepine (diazepam or midazolam, 0.3 mg/kg; IV, IN, rectally) as needed, up to 3 doses over 2 hours. If seizures continue, give phenobarbital (15-20 mg/kg total dose, divided into 4 doses and given IV every 30-60 minutes as needed to control seizures) and start oral phenobarbital (2.5 mg/kg PO q12h) 12 hours after last IV dose. Treat any MWD with stupor or coma with mannitol on admission (1.5 grams/kg, IV, over 30 minutes) and repeat every 4-6 hours for up to 2 additional doses). CNS abnormalities typically resolve with mild or moderate cases of heat stroke. Cortical blindness is common and usually resolves over a period of several days.

Prognosis: Nucleated Red Blood Cells, Heat Injury Severity Scoring System

- A study in 40 dogs[12] demonstrated that 90% of dogs presenting with heatstroke had increased peripheral nucleated red blood cells (nRBC) at presentation, with a cut-off point of 18 nRBC/100 leukocytes corresponding to a sensitivity and specificity of 91 and 88%, respectively, for death. Dogs with nRBC above this cut-off were significantly more likely to have life-threatening complications such as kidney failure and disseminated intravascular coagulopathy, as well. Thus, rapidly screening for the presence of nRBC may be useful to confirm clinical suspicion of heatstroke, and guide aggressiveness of therapy and monitoring.

- A severity scoring system[10] has been validated in dogs with clinical heat stroke that may prove useful to gauge severity of injury and prognosis based on key clinical and laboratory parameters noted within the first 24 hours of admission. Parameters useful to measure include heart rate, blood glucose, and coagulation tests. Clinically, the presence of obesity, acute collapse, shock, seizures, altered mental status, coagulopathy, acute kidney injury, and acute lung injury are documented risk factors for death. While calculating this score is beyond the scope of practice for HCPs, it is key to recognize those parameters and conditions that are significantly associated with outcome and complications, and to document these results, as this guides the aggressiveness of therapy and monitoring.

TABLE 12. MWD HEAT INJURY PROTOCOL[5-10]

PHASE	CLINICAL SIGNS	
MILD (Stress)	Controlled panting, excessive thirst, discomfort	Dehydration typically accompanies heat injury --> treat dehydration and monitor for shock
MODERATE (Exhaustion)	**UN**controlled panting, weakness, ataxia, anxiety, petecchiae/ecchymoses	
SEVERE (Stroke)	Moderate signs, ***PLUS*** CNS signs, collapse, shock	

TREATMENT OF MILD HEAT INJURY

1. Cease work
2. Remove from source of heat (move to shade or air-conditioned area if possible, use fans if available)
3. Offer cool water in small increments frequently
4. Monitor temperature q 15-30 min to ensure mild injury doesn't progress; perform serial physical exams

TREATMENT OF MODERATE AND SEVERE HEAT INJURY -- ANY DOG WITH TEMPERATURE >105^0 F

1. Immediately soak the dog's skin with water – Saturate to the skin!!
2. Continue soaking until body temperature is reduced to <105^0 F.
3. Start IV fluid therapy
4. Follow SHOCK RESUSCITATION PROTOCOL if dog is in shock (See Chapter 6, Figure 33)
5. Give IV fluids at 3-5 mL/kg/hr if not in shock
6. Triage the patient based on severity of injury
7. Protect the airway (intubate or tracheostomy *prn*), treat dehydration or shock, support ventilation *prn*
8. Be prepared to support/correct REBOUND HYPOTHERMIA
9. Dog may be hypothermic on arrival or develop hypothermia during treatment
10. DO NOT USE cold or iced IV fluids, surface cooling with ice, or ice water immersion

REDUCE cooling efforts once the body temperature is <105^0 F. Dry the hair, stop fans, increase room temperature, etc.

CEASE cooling efforts once the body temperature is <103^0 F to prevent rebound hypothermia. Actively warm the dog if temperature is <100^0 F

PROVIDE INTENSIVE MONITORING AND MANAGEMENT

Maintain NORMOTENSION -- Target MAP of >65 mmHg or Systolic BP >90 mmHg

Maintain VENTILATION -- Target RR of 8 - 10 bpm -- Target E_TCO_2 25 - 60 mmHg

Maintain OXYGENATION -- Target SpO_2 >95% with supplemental oxygen *prn*

CONTROL SEIZURES

MIDAZOLAM or DIAZEPAM	0.3 mg/kg -- IV, IO, or INTRANASAL *prn*

TABLE 12: MWD HEAT INJURY PROTOCOL[5-10] (continued)	
MANAGE CEREBRAL EDEMA	
MANNITOL	1 - 2 grams/kg -- IV over 30 min
and	
DEXAMETHASONE	0.5 mg/kg IV ONCE
…or…	
METHYLPREDNISOLONE	30 mg/kg -- IV -- ONCE
CONTROL PATHOLOGIC VENTRICULAR ARRHYTHMIAS	
LIDOCAINE CRI @ 50 - 75 mcg/kg/min	CORRECT H's and T's FIRST

CONTROL HYPOGLYCEMIA	MANAGE ANCILLARY PROBLEMS
▪ SUPPLEMENT IV fluids with 5% dextrose ▪ MONITOR blood glucose q4-6h ▪ AVOID intensive glucose titration	▪ Anti-emetics + gastrointestinal protectants ▪ Potassium Supplementation ▪ Mobility

Heat Injury References

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Hypothermia and Cold Injuries

Hypothermia in MWDs may be caused by exposure to low environmental temperatures (primary hypothermia), or low body temperature due to trauma, toxicity, underling illness, or anesthesia and surgery (secondary hypothermia).[1] Most commonly, HCPs will be presented with dogs suffering secondary hypothermia.

Classification of Hypothermia

MWDs with primary hypothermia can apparently tolerate much more severe hypothermia than MWDs with secondary hypothermia, and adverse effects due to hypothermia have been reported in dogs with secondary hypothermia at significantly closer-to-normal temperatures than patients with primary hypothermia.[1]

- Primary hypothermia is classified as mild (90-99° F), moderate (82-90° F), severe (68-82° F), or profound (less than 68° F).
- Secondary hypothermia is classified as mild (98-99.9° F), moderate (96-98° F), severe (92-96° F), or profound (less than 92° F).

Management of Hypothermia

- Warm hypothermic MWDs rapidly but carefully. Anticipate possible complications. Cardiovascular support (principally IV fluid therapy), management of co-existing problems, and prevention of rewarming complications are necessary (See Table 13).
- Rewarm MWDs at a target rate of increase of 2-4° F per hour.
- Use a combination of methods based on the severity of hypothermia and the MWD's status.
- Rewarm MWDs with mild hypothermia and normovolemia using passive surface warming. Apply external blankets, towels, or other devices to prevent heat loss while the animal 'self-generates' heat. These measures will not be effective as sole measures if shivering is absent.[1]
- Rewarm MWDs with moderate hypothermia using active surface warming.
  - Use externally-applied heat sources such as forced-air devices, warm water bottles, or warm-water circulating heating pads to provide heat to offset the patient's inability to generate heat.
  - Provide IV fluid volume support to maintain normotension and prevent rewarming shock (See Chapter 6, Figure 33).

- Apply heat to the thorax and abdomen, and not the extremities, as this avoids peripheral vasodilatation and prevents the decreased thermoregulatory response seen when extremities are warmed, both of which contribute to persistent hypothermia and "afterdrop."[1,5]

- Rewarm MWDs with severe or profound hypothermia using active core warming.
  - Always use active surface warming concurrently with active core warming.[1]
  - Use warmed IV fluids. The temperature of intravenous fluids should not exceed 108° F to avoid injury to cellular components of the peripheral blood.[1,5]
  - If the MWD is intubated and warming humidifiers are available on anesthesia circuits, use warmed inhaled air.
  - Given potential complications with use, HCPs should not use warm peritoneal or pleural lavage or urinary bladder or rectal lavage with warmed fluids.
  - Warm hypothermic MWDs to a temperature of 98.5° F, and then cease use of all warming methods except passive warming, while providing blood volume support (i.e., IV fluids) at relatively moderate rates to avoid volume overload (10-15 mL/kg/h) that is possible due to earlier cold diuresis [1,5] in hypothermic MWDs being rewarmed.

Complications Related to Hypothermia

- It is most important for the HCPs to recognize potential problems rather than specific temperatures at which to expect these problems.
- Hyperglycemia is common in mild and moderate hypothermia; specific measures to reduce blood sugar are seldom necessary. Hypoglycemia can develop in severely hypothermic patients, and dextrose supplementation (5% in IV fluids) is recommended empirically.
- Hypokalemia is common in mild-to-moderate hypothermia, and supplementation is necessary (KCl in IV fluids, 20 mEq/L) empirically. Hyperkalemia is reported in severe hypothermia; specific measures (e.g., insulin-dextrose administration, bicarbonate administration) may be necessary if potassium is >7-8 mmol/L. Check electrolytes, if able.
- Metabolic and respiratory acidosis are reported in most types and degrees of hypothermia; these typically correct with fluid therapy and patient warming.
- Hemostatic defects are common. MWDs are commonly in a hypocoagulable state with prolonged clotting times, and platelet abnormalities are also noted. Monitor for bleeding diasthesis. Given the inability to correct coagulopathies and thrombocytopenias in MWDs in the deployed setting, any MWD with evidence of bleeding should be evacuated URGENTLY to a veterinary facility.
- Tachycardia and hypertension are common in mild-to-moderate hypothermia. As hypothermia worsens,

bradycardia and hypotension develop, and other cardiac arrhythmias may develop. Monitor continuous ECG and blood pressure. Avoid giving drugs, to include anti-arrhythmic agents, until the body temperature is >90°, as drugs are believed ineffective at temperatures below this.[1,5]

- ***HCPs must be aware that measures to correct hypothermia can actually cause complications to develop, such as "afterdrop" and "rewarming shock;" thus, careful warming and close monitoring are essential when managing hypothermic patients.***[3,5]
  - "Afterdrop" is the continued decrease in core temperature as warming is provided, due to the return of cold peripheral blood to the central circulation. To prevent "afterdrop," it is important to warm the patient's trunk (chest and abdomen), not the extremities.
  - "Rewarming shock" develops with excessively rapid warming and is due to the sudden development of systemic vasodilatation. This vasodilatation causes hypotension at a time when the circulatory system may not be able to react. The systemic hypotension is aggravated by the increased metabolic demand that develops as hypothermic patients are rewarmed, which increases the demand for perfusion. To prevent or reduce "rewarming shock," IV fluid therapy must be provided and assessment of volume status (e.g., serial body weight measurement, clinical signs of hydration), systemic blood pressure, and tissue perfusion (e.g., evaluation of CRT, lactate clearance, change in mentation, urine output) must be monitored carefully.

Cold-induced Injury

Cold-induced injuries include non-freezing and freezing injuries, typically to an extremity, and tend to be related to geographic location (i.e., freezing climates) and use of the animal (e.g., search dogs).

Non-freezing Injury

Non-freezing injuries typically involve the extremities, occur despite the tissue not actually freezing, and are commonly due to prolonged cold exposure. In humans, common terms to describe these types of injuries are "chilblains" and "immersion foot" or "trench foot;" similar terms are not used in veterinary medicine.

With non-freezing injuries, extremities (ear pinnae, paws, tail tip, scrotum) are exposed to cold temperatures above freezing for prolonged periods (>12 hours), causing intense erythema of the skin, pain, and pruritus. If skin is exposed to damp conditions or submerged and exposed to cold, tissue edema and maceration may also develop.

Treatment of non-freezing cold injuries involves removing the MWD from the cold environment and passively warming the affected tissues slowly. Passive warming of non-freezing injuries can be accomplished by moving the MWD to a warm room (e.g., hospitalize, indoor facility) and gently wrapping the patient or affected body part in warm blankets or towels.

TABLE 13. MANAGEMENT OF HYPOTHERMIA IN MWDS

1. Warm rapidly but carefully.
   a. Increase the body temperature by 2-4° F per hour.
   b. Warm to a temperature of 98.5^0 F, and then cease use of all warming methods except passive warming.
2. **Mild hypothermia, adequate blood volume** – Warm using passive surface warming (wrap MWD in blankets or towels; hospitalize in warm environment).
3. **Moderate-to-severe hypothermia;** mild hypothermia with inadequate blood volume.
   a. Warm using active surface warming (use of externally-applied heat sources such as forced-air devices, warm water bottles, non-electric heating pads, or dryers)
   b. Apply heat to the thorax and abdomen, and not the extremities.
   c. Perform passive warming as above.
4. **Severe-to-profound hypothermia**
   a. Warm using active core warming (heat inhaled air provided by endotracheal tube, warm intravenous fluids).
   b. Perform active and passive warming as above.
5. Provide cardiovascular support.
   a. Provide intravenous fluids at relatively moderate rates (2-3 times maintenance rates, or 2-10 mL/kg/h) until normothermic.
   b. Once resuscitated and stabilized, provide continued intravenous fluids.
   c. Provide oxygen supplementation for severe-to-profound hypothermia to reduce risk of cardiac arrhythmias.
6. Anticipate and manage complications.
   a. Perform continuous ECG monitoring, and treat malignant arrhythmias using lidocaine 2 mg/kg IV bolus followed by lidocaine CRI 50-75 mcg/kg/min as needed. ***Do not treat arrhythmias until body temperature >90°.***
   b. Monitor for glucose, electrolyte, and acid-base abnormalities every 6-12 hours.
   c. Monitor platelet count and coagulation parameters every 6-12 hours.
   d. Provide analgesia as needed (See Chapter 16).
   e. Perform continuous or intermittent blood pressure monitoring, lactate clearance, changes in mentation, and urine output to monitor for "rewarming shock."
   f. Perform continuous temperature measurement, to monitor for correction of hypothermia and "afterdrop."

Freezing Injury

Freezing injury, or "frostbite," is the development of cold injury in which tissues actually become frozen, with crystallization (ice formation) of tissue and cell water. Frostbite is seen at environmental temperatures below 32° F and primarily affects the distal extremities, ears, nose, scrotum, and tail. Frostbite varies in severity from superficial (1st degree frostbite) to deep injury (4th degree frostbite).

Clinical signs of superficial frostbite (1st and 2nd degree frostbite) include a grey-to-white, waxy appearance of affected skin; blistering of affected skin may be present with 2nd degree frostbite. Clinical signs of deep frostbite (3rd and 4th degree frostbite) include involvement of the entire epidermis, but no subcutaneous tissues (3rd degree) to involvement of subcutaneous tissues, to possibly include muscle and bone (4th degree frostbite). Tissues affected with deep frostbite may be black and friable. In all cases of frostbite, pain may be intense, especially during rewarming of tissues.

Management of MWDs with freezing injury is summarized in Table 14 on the next page. Treatment of frostbite involves rapid warming of affected tissues, overall patient management (e.g., treatment of whole-body hypothermia,
trauma, or shock as appropriate), analgesia, and protection of affected tissues.

- Affected tissues may be warmed by immersion in a water bath that is 104-108° F for at least 20 minutes or until thawing has occurred, or by wrapping the affected tissue with warm, wet towels for 15 to 20 minutes, changing the towels every 5 minutes.
- Do not use dry heat to warm tissues, and never rub or massage the tissues, as further injury may occur.
- Provide systemic analgesia (See Chapter 16), as frostbite is extremely painful.
- Protect the affected tissues by applying loose protective bandages, minimizing movement (confine to a cage), and attaching a bucket-collar device (See Figure 21 and Figure 22) to prevent self-trauma.
- Antibiotic use is not recommended.
- Aseptically aspirate large blisters that develop.

TABLE 14. MANAGEMENT OF FREEZING INJURY (FROSTBITE) IN MWDS
1. Treat whole-body hypothermia, trauma, or shock as directed in supporting chapters. 2. Provide systemic analgesia (See Chapter 16). 3. Warm frozen tissues gently and slowly, using 1 of 2 methods: a. Immerse in a water bath that is 104° to 108° F for at least 20 minutes or until thawing has occurred. b. Wrap with warm, wet towels for 15 to 20 minutes, changing the towels every 5 minutes. ***NOTE: Do not use dry heat or rub or massage tissues to warm tissues.*** 6. Apply loose protective bandages. 7. Minimize movement (confine to a cage). 8. Apply a bucket to the collar to prevent self-trauma. 9. Aseptically aspirate large blisters that develop. Do not use empiric antibiotics. 10. Manage open, infected, or necrotic wounds (See Chapter 14).

Cold Injury References

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Snake and Insect Envenomation

Insect and snake envenomation of dogs is possible in deployed settings (See Table 15). This chapter focuses on the CENTCOM AOR exclusively. Refer to local guidance for other geographic areas.

- Specific treatment with geographic area-specific antivenin is optimal for patients with moderate-to-severe clinical signs.
- Although data are limited, antivenin decreases morbidity and may reduce mortality (especially for bites to the trunk and upper limbs, which have the highest mortality rates).[1-3]
- Antivenin is typically only available in select Role 2 and Role 3 facilities because antivenin use – for humans and dogs – is highly regulated and governed by theater policy. The CENTCOM Policy for Snake and Scorpion Antivenins, which provides regulatory guidance for antivenin management, use, and reporting, is the primary reference to guide use of snake and scorpion antivenin in dogs.[4]
- Antivenins, especially those that contain whole immunoglobulin components, must be used with caution, due to the potential to induce allergic reactions.[1-3,5,6] Although dosing in dogs is empiric, if used, antivenins should be given to effect to control clinical signs.

Insect Envenomation

Insect envenomation typically causes local pain, erythema, and swelling (angioedema or urticaria). Some insect venoms cause a locally extensive wound that often take several days to manifest, while others may cause systemic anaphylaxis.

Venomous Scorpions

Venomous scorpions that typically induce severe clinical signs include the Arabian or Asian Fat-Tailed Scorpion (*Androctonus amoreuxi*), the African Ground Scorpion (*Hottentotta alticola*), and *Hemiscorpius lepturus* (no common name).

Venomous Spiders

Venomous spiders that typically induce severe clinical signs include the Mediterranean Black Widow (*Latrodectus tredecimguttatus/lugubris*) and the Tarantula or Wolf spider (*Lycosa signoriensis*). Note that sopulgids (Camel spiders) are NOT venomous, but may cause a painful bite.

Supportive Care for Scorpion Stings and Spider Bites

- Coordinate MEDEVAC (Urgent) directly to appropriate medical facilities where antivenin is stored. Remote sites should request overfly (bypass the local MTF/VTF) directly to appropriate facilities.
- Ensure a patent airway and provide supplemental oxygen and ventilation, as needed.
- Place an IV catheter and obtain a CBC, blood chemistry panel, and urinalysis.
- Start crystalloid fluids IV to maintain hydration and perfusion and to facilitate diuresis of toxin. Fluid rate should be 3 mL/kg/hr for 12 hours, then reduce to 2 mL/kg/hr for another 12 hours, pending patient improvement.
- Administer 50 mg diphenhydramine IM and wait 30 minutes after initial dose before administering antivenin. Repeat diphenhydramine every 8 hours for a total of 3 doses.

  NOTE: MWD handlers may have been issued diphenhydramine and may have initiated therapy before presentation. Do not give diphenhydramine IV because it can cause severe hypotension in dogs.

- Manage any open wounds that develop (See Chapter 14).
- Treat pain if noted (See Chapter 16). NOTE: Do not treat with NSAIDs, given the propensity for envenomated dogs to develop coagulopathies and thrombocytopenia and thromobocytopathia.
- If systemic anaphylaxis is suspected based on the history and clinical signs (weakness, peracute vomiting or diarrhea, collapse, or hypotension), treat the MWD as above, and treat with IV fluid therapy as for shock (See Chapter 6, Figure 33) and give epinephrine (0.5-1 mg per dog, IM or IV; repeat if necessary every 20-30 minutes).
- Hospitalize the patient and provide supportive care until resolved or evacuated.

Antivenom Use for Scorpion Stings and Spider Bites

Scorpion Stings

Administer Saudi Polyvalent Scorpion (Equine) $F(ab)_2$ if the specific scorpion is identified as one of those listed above and if systemic clinical signs of evenomation are present. Dosing is empiric: Initially, dilute 5 of the 1 mL ampules in 100 mL 0.45% saline and infuse IV over 60 minutes.

Spider Bites

Antivenin is only available for Black Widow spider bites. Administer Antivenin Latrodectus mactans for witnessed Black Widow spider (*Latrodectus tredecimguttatus/lugubris*) bites and with systemic evenomation clinical signs. Dosing is empiric: Reconstitute 1 vial, dilute in 100 mL 0.45% saline, and infuse IV over 60 minutes.

Snake Envenomation

- Clinical signs of bites by venomous snakes can vary tremendously, principally depending on the type of snake involved, location and number of bites, and the amount of venom injected. HCPs should become familiar with indigenous snakes in deployed areas and seek guidance on specific management recommendations in preparation for deployments. Information on indigenous venomous snakes in each AO can be found in the Veterinary Medical Threat Brief from the MD(VSS) or Medical Brigade Staff Veterinarian.
- Vipers and elapids are the most common venomous snakes of concern in the CENTCOM theater (See Table 15).
- In general, snakebites by most venomous vipers cause severe pain, variable degrees of local swelling that may spread, and varying degrees of local tissue necrosis. Many MWDs will also develop systemic signs of pain. Some dogs will develop life-threatening complications of envenomation, but this is uncommon. Generally, clinical experience shows that most MWDs bitten by vipers on the face or lower leg will survive, with or without antivenin treatment. Dogs bitten on the upper limb or torso, however, have markedly increased mortality rates. It is prudent to recommend that any MWD bitten by a venomous snake be evacuated URGENTLY for optimal management. Follow guidelines below while coordinating evacuation.
- Unwitnessed envenomation is common. The presence of fang marks does not necessarily mean that envenomation has occurred – "dry bites" are common. Conversely, envenomation may have occurred without obvious puncture wounds evident.
- Injection of venom typically causes marked localized swelling and edema, intense local pain, and discoloration of the surrounding tissues due to necrosis, with oozing of venous blood.
- Systemic signs frequently observed include pain, lethargy, vomiting, and weakness. Many MWDs will develop laboratory evidence of thrombocytopenia and coagulopathy (decreased platelet count, prolonged coagulation times) but true spontaneous hemorrhage is rare.

Supportive Care for Venomous Snake Bites

- Coordinate MEDEVAC (Urgent) directly to appropriate medical facilities where antivenin is stored. Remote sites should request overfly (bypass the local MTF/VTF) directly to appropriate facilities.
- Hospitalize any MWD with history of or signs suggesting envenomation for at least 12 hours to monitor progression.
- Ensure patent airway, provide supplemental oxygen, and ventilation, as needed.
- Place an IV catheter and obtain a CBC, blood chemistry panel, and urinalysis.
- Start crystalloid fluids IV to maintain hydration and perfusion and to facilitate diuresis of toxin. Fluid rate should be 3 mL/kg/hr for 12 hours, then reduce to 2 mL/kg/hr for another 12 hours, pending patient improvement.

- Administer 50 mg diphenhydramine IM initially, and then once every 8 hours for a total of 3 doses. Wait 30 minutes after initial dose before administering any antivenin.

  NOTE: MWD handlers may have been issued diphenhydramine and may have initiated therapy before presentation. Do NOT give diphenhydramine IV; it can cause severe hypotension in dogs by this route.

- Manage any open wounds that develop (See Chapter 14).
- Treat pain if noted (See Chapter 16). NOTE: Do not treat with NSAIDs, given the propensity for envenomated dogs to develop coagulopathies.
- ***Do NOT use tourniquets, ice packs, heating, or local vasoconstriction (***e.g., injection of epinephrine locally) in an attempt to slow venom spread.
- Confine MWDs to minimize venom distribution.
- If systemic anaphylaxis is suspected based on the history and clinical signs (weakness, peracute vomiting or diarrhea, collapse, or hypotension), treat the MWD as above and also, treat with IV fluid therapy as for shock (See Chapter 6, Figure 33), and give epinephrine (0.5-1 mg per dog, IM or IV; repeat if necessary every 20-30 minutes).
- Treat mild envenomations (signs localized to face or lower limb that do not progress or progress slowly) with analgesics (See Chapter 16), diphenhydramine (2-4 mg/kg IM q8h), and IV fluid therapy (3-5 mL/kg/h for at least 12 hours, then reduce to 2-3 mL/kg/h for another 12 hours). See recommendations for antivenin use.

Antivenom Use for Viper and Elapid Envenomation

- Treat moderate-to-severe envenomation (rapidly progressive signs originating on the lower limb or face, any MWD with systemic signs, and any MWD with upper limb or torso bites) with analgesics (See Chapter 16), diphenhydramine (2-4 mg/kg, IM, q8h), IV fluid therapy using the guidelines recommended for shock therapy initially (See Chapter 6, Figure 33), and antivenin (if available) following the recommendations that follow. Monitor closely for progression.
- For suspected or unwitnessed envenomation by an unknown species of snakes, use the Razi Polyvalent Snake Antivenin, as it has the broadest spectrum of antivenin activity for the majority of venomous snakes in theater. Intradermal testing for potential allergic reaction is unreliable in clinical cases; do not delay antivenin administration to perform this testing. Emergency interventions should be initiated as needed to treat anaphylaxis.
  - Dilute 2 ampules of Razi Polyvalent Snake Antivenin in 100 mL 0.45% saline and infuse IV over 60 minutes.
  - Dose “to effect” with dosing targeted to visible reduction in severity and progression of swelling and pain locally at the site of envenomation, and to improve the dog’s comfort.
  - Be prepared to administer 1-2 additional ampules over an hour if swelling continues to increase or spread, pain locally and systemically is not abated, or the patient’s overall condition deteriorates. Additional antivenin may be needed if clinical signs persist, worsen, or recur. Antivenin is effective up to 24 hours after envenomation; consider use even if there was delay in evacuation to the facility for care.

- For witnessed envenomation by vipers or elapids for which $F(ab)_2$ antivenin is available, use Saudi Polyvalent Antivenin monotherapy, or a combination of Saudi FAVIREPT Polyvalent Antivenin and the Haffkine/ Vinsbio (Indian) Antivenin.
  - Dilute 4 of the 10 mL ampules of Saudi Polyvalent Snake Antivenin $F(ab)_2$ in 350 mL of 0.45 % saline and infuse IV over 60 minutes.
  - Alternatively, dilute 2 of the 10 mL ampules of Saudi FAVIREPT Polyvalent $F(ab)_2$ in 250 mL 0.45% saline and infuse IV over 60 minutes, PLUS give 1 of the 10 mL ampules of Haffkine/Vinsbio (Indian) in 500 mL 0.45% saline infused IV over 60 minutes.
- Treat presumed adverse effects of antivenin (increased temperature, restlessness, panting, vomiting, urticaria or angioedema, weakness, collapse, hypotension) by temporarily slowing or stopping the antivenin infusion and giving diphenhydramine (2-4 mg/kg, IM). Consider epinephrine (0.5-1.0 mg per dog, IM or IV) if signs of shock develop.

NOTE: Use of fresh frozen plasma (FFP) is controversial for snake envenomation. Currently canine FFP, if available, should only be considered in cases of severe systemic coagulopathy with active bleeding.

TABLE 15. VENOMOUS SNAKES, CENTCOM AOR

Location	Type	Common Name	Scientific Name	1st Choice Antivenin	2nd Choice Antivenin
Afghanistan	Viper	Puff adder	*Bitis arietans*	Saudi	FAVIREPET
Afghanistan	Viper	Saw-scaled vipers	*Echis spp*	Razi	Saudi, FAVIREPT, Haffekine/Vinsbio
Afghanistan	Viper	MacMahon's viper, Asian sand viper	*Eristocophis macmahoni*	Razi	Saudi, FAVIREPT
Afghanistan	Viper	Haly's pit viper	*Gloydius spp*	Razi	None
Afghanistan	Viper	Levantine vipers	*Macrovipera lebetina subspp*	Razi	None
Afghanistan	Viper	Persian horned viper	*Pseudocerastes persiscus*	Razi	None
Afghanistan	Elapid	Indian krait	*Bungarus caeruleus*	FAVIREPT	Razi, Saudi, Haffekine/Vinsbio
Afghanistan	Elapid	Desert Cobra/ Desert Black Snake	*Walterinnesia aegyptia*	Saudi	Razi
Afghanistan	Elapid	Egyptian cobra	*Naja haje*	FAVIREPT	Saudi, Razi
Afghanistan	Elapid	Indian cobra, Caspian or Central Asian cobra, Oxus cobra	*Naja naja, Naja oxiana*	Razi	FAVIREPT, Saudi
Iraq	Viper	Horned vipers	*Cerastes spp*	Saudi	FAVIREPT
Iraq	Viper	Levantine vipers	*Macrovipera lebetina subspp*	Razi	None
Iraq	Viper	Persian horned viper	*Pseudocerastes persiscus*	Razi	None
Iraq	Elapid	Desert Cobra/ Desert Black Snake	*Walterinnesia aegyptia*	Saudi	Razi

TABLE 16. SCORPION, SPIDER, AND SNAKE ANTIVENIN SELECTION			
Antivenin	**Covered Scorpions**	**Dosing**	**Administration**
Saudi Polyvalent Scorpion (Equine) F(ab)$_2$ NSN: 6505-08-140-1520	Yellow Scorpion, Death Stalker Scorpion *(Leiurus spp),* Black Scorpion and Fat-Tailed Scorpion *(Androctonus spp),* *Buthus spp* (no common name)	Five 1 mL ampules initially. Further dosing usually not needed, but dose to effect.	Dilute in 100 mL of 0.45% saline. Infuse IV over 60 min.
Antivenin	**Covered Spider**	**Dosing**	**Administration**
Antivenin Latrodectus Mactans NDC: 0006-4084-00	Black Widow Spider *(Latrodectus spp)*	1 vial	Dilute in 100 mL of 0.45% saline. Infuse IV over 60 min.
Antivenin	**Covered Snakes**	**Dosing**	**Administration**
Razi Polyvalent Snake Antivenin, IgG NSN: 6505-08-139-1454	**ANY UNWITNESSED SNAKE BITE**, *Echis carinatus,* *Vipera lebetina,* *Vipera albicornuta,* *Pseudocerastes persicus*, *Naja spp*, *Agkistrodon halys*	2 ampules initially. Repeat dosing as needed to effect to control signs.	Premedicate with diphenhydramine 50 mg IM at least 30 min before use. Dilute antivenin in 100 mL 0.45% saline and infuse IV over 60 min.
Saudi Polyvalent Snake Antivenin, F(ab)$_2$ NSN: 6505-08-139-1452	*Echis carinatus,* *Vipera lebetina,* *Vipera albicornuta,* *Pseudocerastes persicus*, *Naja spp,* *Agkistrodon halys*	2 ampules initially. Repeat dosing as needed to effect to control signs.	Premedicate with diphenhydramine 50 mg IM at least 30 min before use. Dilute antivenin in 100 mL 0.45% saline and infuse IV over 60 min.

Snake & Insect Envenomation References

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Blast, Burn and Crush Injuries

With the increased use of improvised explosive devices, blast injury is not uncommon in MWDs. However, there is little definitive clinical information available for managing blast injury in dogs, so recommendations are similar to management for human patients. Burn and crush injuries are less common, but may be encountered.

Blast Injury

Be prepared to provide care for MWDs exposed to bomb blasts and other explosions. Recognize that blast injuries may be subtle or occult for days, with MWDs appearing stable on initial evaluation. Figure 43 (next page) provides the recommended general approach to assessing MWDs exposed to blast.

Blast Injury Mechanisms[1-3]

Blasts produce injury through primary effects of the blast overpressure wave, secondary injury due to penetrating objects displaced by the explosion impacting victims, tertiary injury due to victims physically being displaced into objects, and quaternary injury due to complications resulting from any combination of injury from primary, secondary, or tertiary injuries or unrelated to these mechanisms.

Initial Management of Blast Injuries

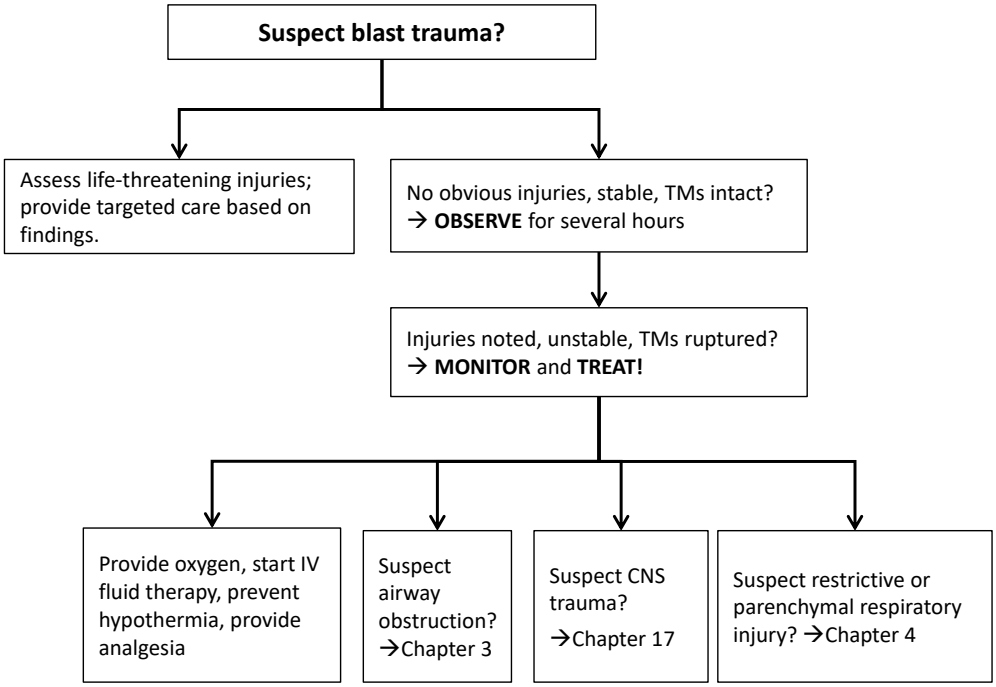
Generally, the approach to blast-injured MWDs is the same as for any other type of trauma – FOCUS on life-threatening problems first, followed by targeted support based on findings, with emphasis on a detailed secondary evaluation and care as needed once the patient is stabilized.

During initial care, focus on those types of life-threatening injuries commonly seen with blasts, especially respiratory distress due to airway obstruction or trauma, pneumothorax, pulmonary contusions, and hemothorax; traumatic amputations or serious bleeding; hemoperitoneum; CNS trauma; air embolism; and shock.

While tympanic membrane (TM) rupture in and of itself is a minor injury, experience suggests that it is a marker of more severe systemic injury, and patients with TM rupture should be observed carefully for signs suggesting the development of other injuries.[2-3] The absence of TM rupture, however, does not exclude potentially life-threatening internal injuries, based on recent data from humans exposed to blasts.[3]

Recognize delayed onset of clinical signs. Many injuries from blasts may not manifest for many hours, to include pulmonary contusions, “blast lung,” concussions and mild TBI, and bowel hemorrhage with perforation and peritonitis. Serial monitoring is critical to detect early signs of impending decompensation due to these delayed problems. Any MWD exposed to blast should be evacuated to a veterinary facility as soon as possible for detailed evaluation and observation. If evacuation is not possible or is delayed, hospitalize in the MTF for 12-24 hours for close observation.

Figure 43. General Approach to Military Working Dogs Exposed to Blasts.


Suspect blast trauma?
Assess life-threatening injuries; provide targeted care based on findings.
No obvious injuries, stable, TMs intact? → **OBSERVE** for several hours
Injuries noted, unstable, TMs ruptured? → **MONITOR** and **TREAT!**
Provide oxygen, start IV fluid therapy, prevent hypothermia, provide analgesia
Suspect airway obstruction? →Chapter 3
Suspect CNS trauma? →Chapter 17
Suspect restrictive or parenchymal respiratory injury? →Chapter 4

Burn Injury

Burn injuries in MWDs are typically caused by fires, motor vehicle mufflers, stoves, caustic chemicals, or explosions. While uncommon, these injuries can cause not only severe pain and complicated local wounds, but also result in serious metabolic abnormalities and systemic infection that can lead to life-threatening compromise.

Burn Classification in MWDs[4-6]

Burns affecting dogs are physically similar to those in humans. Hair may need to be carefully clipped over burned areas for adequate assessment. Superficial burns are red and painful, similar to sunburn, involving the outer layer of the epidermis. Superficial partial-thickness burns are red or mottled, with epidermal sloughing, fluid leakage, swelling, and extreme hypersensitivity (pain), involving the epidermis and variable amounts of dermis. Hair should not easily pull out. Deep partial-thickness burns are black or yellow-white and hair follicles are
destroyed, and the skin surface is dry. These burns are generally less painful, as nerve endings are destroyed. If any hair remains, it will pull out easily. Full-thickness burns are black, dry, and leathery. These burns have destroyed the epidermis and dermis and expose underlying connective tissue, muscle, and bone. Any eschar that forms is painless.

Inhalation Injury

Burn patients may have significant inhalation injury. Clinical signs of inhalation and pulmonary injuries may not manifest for several hours. Clinical signs of inhalation injury include stertor or stridor, harsh cough or upper airway sounds, coughing, production of dark sputum, tachypnea, and respiratory distress. MWDs with inhalation injury should be observed closely for need for orotracheal intubation or (uncommonly) tracheostomy to manage the airway. Intubate or perform tracheostomy for any MWD with observed respiratory distress or if in doubt about the patency of the airway (See Chapter 3).

Estimation of Total Body Surface Area (TBSA) Burn Extent in Dogs

Determine the severity of the burn once the MWD has been resuscitated and stabilized. General characteristics of the wound that are important to examine include color, texture, presence or absence of pain, moistness, and extent of swelling, if present.

Estimate the percent of the total body surface area (TBSA) that is burned by using a modification of the "Rule of 9s" used for humans:[4]

ADD the estimated percent of burn from EACH of the following body areas:

- Head and neck (H/N) – 9%
- Chest (C) – 18%
- Abdomen (A) – 18%
- Each forelimb (L FL, R FL) – 9%
- Each hindlimb (L HL, R HL) – 18%

TBSA = H/N + C + A + L FL + R FL + L HL + R HL. For example, the estimated TBSA burn for a dog with burns to the chest and abdomen and left forelimb would be 18% (chest) + 18% (abdomen) + 9% (L FL) = 45%.

The percent TBSA is important in assessing severity, anticipating problems, and determining prognosis. Patients with TBSA >20% often have severe metabolic problems (e.g., hypovolemic shock, albumin and electrolyte losses, acidoses, renal failure); patients with TBSA >50% have a poor prognosis.[4] Any discussion of prognosis must take into consideration not only the TBSA but also the severity of burn. Note that initial evaluation of severity of burn wound may be inaccurate, as wounds often progress over a period of 3-7 days before completely manifesting ultimate severity.[4-5]

General Patient Management Recommendations[4-6]

- Monitor and treat for complications related to burn injury, to include shock, fluid losses, respiratory problems, and electrolyte abnormalities, see appropriate chapters. Stabilize the patient first. Manage pain using appropriate analgesics (See Chapter 16 and Table 17).
- Cool the burned skin using cool water (45-65° F) by immersion, application of compresses, or gentle spray for at least 30 minutes. Do not apply ice to any burned skin, as the vasoconstriction it causes may impede wound healing and may worsen the extent of tissue damage. Measure the patient's rectal or esophageal temperature frequently to monitor for and prevent hypothermia.

- Minimize potential contamination of burned skin. Wash hands thoroughly before handling patients; wear clean exam gloves (superficial burns, superficial partial-thickness burns) or sterile surgical gloves (deep partial-thickness burns, full-thickness burns); do not contact wounds with things such as personal clothing, stethoscopes, or other instruments or monitors; wear barrier protection when handling deep partial-thickness burns and full-thickness burns; change gloves and wash hands before handling other burn wounds and invasive devices on the same patient.
- Follow strict aseptic technique when placing invasive devices and use clean examination gloves whenever handling catheters, adapters, fluid lines, etc. Unless absolutely necessary, do not place invasive devices through burned skin. Provide antibiotic coverage using the guidelines in Chapter 14 only for MWDs presumed to be immunocompromised, with pneumonia or acute lung injury, or with sepsis or suspected sepsis.
- Provide excellent nursing care. Turn or rotate the MWD every 4 hours if recumbent, and perform Passive Range of Motion (PROM) exercises of all limbs except burned limbs every 4 hours. Provide soft, padded bedding. Prevent urine scalding and fecal soiling. Allow MWDs to eat and drink if able.

Specific Burn Wound Management Recommendations[4-6]

- Depending on severity and extent of burn, the patient may require daily heavy sedation or general anesthesia to allow debridement and management. Extreme care must be taken to monitor burn patients adequately during sedation or anesthesia (See Table 17).
- Superficial or superficial partial-thickness burns are generally managed with daily cool water lavage, followed by topical silver sulfadiazine cream application until healed or the wound worsens.
- Deep partial-thickness and full-thickness burns need varying degrees of daily wound debridement. This may be accomplished by use of conservative debridement, chemical debridement, or surgical debridement.
    - Conservative debridement of deep partial-thickness and full-thickness burns involves hydrotherapy using sterile saline lavage under light pressure or application of a wet-to-dry saline dressing under a light bandage for several hours, followed by removal of obvious necrotic or dead tissue using aseptic technique. Surgical debridement may be necessary in very deep or widespread wounds to more aggressively remove necrotic tissue; however, HCPs should not routinely perform surgical debridement – MWDs should be evacuated to veterinary facilities for this level of care.
    - Following debridement, apply silver sulfadiazine (SSD) cream, petrolatum, or hydrogel dressings in a thin layer directly on the wound and cover the burn with a non-adherent dressing (if the wound area is bandaged) or leave the burn uncovered (if bandaging is not permissible due to wound size or location).
- Bandage burn wounds if the burn area is amendable to application (i.e., the bandage can be placed without increasing patient discomfort, the burn area is relatively small, and the bandage will not increase the potential for wound injury). If there is any doubt about whether to bandage a burn wound or not, it is better to leave the wound unbandaged. In most cases, a wet-to-wet bandage is recommended to keep wounds moist and improve comfort. Change bandages at least daily or more often if wound exudate is excessive or the bandage becomes soiled.

TABLE 17. MANAGEMENT OF BURN WOUNDS IN MILITARY WORKING DOGS
Provide heavy sedation or general anesthesia to allow debridement and management, as necessary.
Superficial or superficial partial-thickness burns: ▪ Perform daily cool water lavage. ▪ Apply topical silver sulfadiazine cream after cool lavage.
Deep partial-thickness and full-thickness burns: ▪ Perform daily wound debridement as necessary: ▪ Perform hydrotherapy using sterile saline lavage under light pressure, or, ▪ Apply a wet-to-dry saline dressing under a light bandage for several hours, followed by removal of obvious necrotic or dead tissue using aseptic technique.
Protect burn wounds: ▪ Apply silver sulfadiazine cream in a thin layer directly on the wound. ▪ Apply a light protective bandage, if the burn area is amendable to application.

Crush Injury and Crush Syndrome

- Crush injury is defined as injury due to compression of extremities or other parts of the body that causes muscle swelling or trauma, with or without neurological or orthopedic problems in the body parts. Body areas most commonly involved are the limbs and torso.
- Crush syndrome develops when crush injury is extensive and prolonged, causing systemic manifestations. These systemic effects are due to traumatic rhabdomyolysis (muscle breakdown) and reperfusion syndrome (release of potentially toxic muscle cell components and electrolytes into the circulatory system) after sudden release of pressure over the crushed limb or torso. Acute hypovolemia and metabolic abnormalities are common and can be severe (even fatal), and myoglobinuria from trauma to muscles frequently may cause or exacerbate renal failure if untreated.
- Crush injuries and crush syndrome in MWDs are expected after building collapses, most frequently after natural disasters or explosions. In humans, the incidence of crush syndrome is 2-15% with approximately 50% of those with crush syndrome developing acute renal failure. Of those with renal failure, 50% need dialysis. Crush syndrome is rarely reported in animals.[7,8]

Pathophysiology

- Crush injury develops after muscle injury and muscle cell death. Three mechanisms are responsible for the death of muscle cells, to include direct cell lysis by the force of the crush; direct pressure on muscle cells causing muscle ischemia, development of anaerobic metabolism and lactic acidosis, and cell membrane disruption and leakage; and vascular compression or disruption, with loss of blood supply to muscle tissue.
- These mechanisms cause the injured muscle tissue to generate and release a number of substances that may be toxic in the general circulation. The crushing force actually serves as a protective mechanism, preventing these toxins from reaching the central circulation. Once the patient is extricated and the force is

released, reperfusion injury is prevalent due to release of toxic compounds and reactive oxygen species. Reperfusion injury may continue for as long as 60 hours after release of the crush injury.

- Other consequences of reperfusion include massive third spacing of fluids in crushed tissues, leading to hypovolemia and shock and exacerbating renal injury, and leading to compartment syndrome.

Clinical Presentation

Clinical signs of crush injury/crush syndrome include some or all of the following:

- Skin injury of the affected body part (may be subtle and less impressive than other signs)
- Limb swelling (may be delayed)
- Paresis or paralysis (may be mistaken as spinal cord injury)
- Loss of sensation (may mask the severity of underlying injury)
- Pain (typically becomes severe with reperfusion)
- Absent or weak extremity pulses
- Discolored urine due to myoglobinuria or hematuria or both
- Hypotension due to hypovolemia (dehydration, hemorrhage, third spacing of fluids) is commonly present and may be severe
- Massive third spacing (often causes or exacerbates compartment syndrome and renal failure)
- Metabolic abnormalities (hypocalcemia, hyperkalemia, and lactic acidosis)
- Clinical signs of compartment syndrome (severe pain in the involved extremity, pain on passive stretching of the involved muscles, decreased sensation to the affected limb)
- Renal failure (due to rhabdomyolysis and secondary myoglobinuric acute tubular necrosis).

Patient Management

- Treat MWDs, if possible, before and during extrication.
- Maintain a high index of suspicion, as MWDs with crush injury may present initially with few signs or symptoms. Delayed treatment leads to poor outcome.
- Most crush syndrome patients have an extensive area of involvement such as a lower extremity and/or the pelvis. It requires more involvement than just one paw. Also, the crushing force must be present for some time before crush injury syndrome can occur.
- The syndrome may develop in <1 hour in a severe crush situation, but usually it takes 4 to 6 hours of compression for the processes that cause crush injury syndrome to take place.
- The hallmark initial treatment for crush syndrome is IV fluid therapy before release of pressure and contin-

ued during extrication and evacuation. Place multiple IV lines, because the MWD will require large fluid volumes and there is a risk of catheter dislodgement during extrication. Normal saline is the initial fluid of choice. Avoid fluids with potassium.

- Once compression is removed, maintain aggressive fluid therapy. Specific guidelines for fluid volumes to administer are difficult to provide. As a starting point, use a rate of 3-5 mL/kg/hr to improve pulse quality, blood pressure (if possible to measure), CRT, and mentation. Try to estimate urine output – the goal is to maintain urine output >1-2 mL/kg/h.
- Alkalinization of the blood with bicarbonate (as is done for humans) is likely not going to be feasible. Thus, HCPs should focus on aggressive IV fluid therapy to correct dehydration and promote diuresis pending extrication and evacuation.
- Anticipate secondary complications. MWDs with crush injury should be treated initially as any other multiple trauma victim.
- Compartment syndrome is rare in dogs; this seems to be a much more common and more severe problem in humans, so extreme measures to control intracompartmental pressures like fasciotomy are unwarranted.
- Wounds should be cleaned and covered with sterile dressings in the usual fashion. Splint fractures if possible.
- Provide analgesia to any MWD with crush injury or crush syndrome (See Chapter 16).

Blast, Burn and Crush Injury References

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CHAPTER 13

Long Bone Fractures

General Considerations

- Recognize and manage life-threatening problems FIRST. Fractures and muscle, tendon, or ligament injuries are rarely life threatening. Resuscitate and stabilize life-threatening problems first. Provide treatment to prevent further compromise to the fracture site and neurovascular structures and minimize infection risk.
- Recognize long bone fractures. MWDs with fractures will have varying degrees of lameness and will likely have limb deformity, swelling, pain, and loss of function. Open fractures are generally obvious, but pose greater risk of local and systemic infection and loss of function. See **Management of Open Fractures** in this chapter for specific guidance.
- Provide analgesia and confine the MWD. Any MWD with possible fractures or joint injury should initially be given parenteral analgesia, continued orally once stabilized (See Chapter 16). Any MWD with possible fractures should be confined to its kennel or small space at all times, with limited opportunities to go outside to urinate and defecate (three times daily as a minimum). Use a make-shift sling placed under the abdomen while walking patients outside. Analgesia and confinement may be the only treatment necessary or feasible, as noted below.

Long Bone Fractures and Joint Abnormalities of the Lower Limbs

HCPs should stabilize any suspected fracture or joint abnormality of the long bones distal to the elbow and knee (radius/ulna, tibia/fibula).

- Manage wounds as per Chapter 14 and then apply splints (e.g., SAM splints) to immobilize the fracture site, ensuring the joints above and below the fracture site are immobilized. Apply buttresses made of layers of cast padding or non-adherent dressing around footpads and any wounds. Apply about twice as much cast padding as is used for people. Generally, it is best to leave the nails of the middle two toes exposed, to allow monitoring for swelling.
- Cast application is not recommended, as cast pressure or friction sores are extremely common with MWDs and complicate recovery. MWDs tolerate splints and bandages poorly, so any MWD with a bandage or splint applied must wear a device to prevent self-mutilation or bandage removal (See Figure 21 and Figure 22).
- Splints and bandages generally need to be changed at least every other day. Change more frequently if soiled, wet, or loose.

Long Bone Fractures and Joint Abnormalities of the Upper Limbs

In MWDs, fractures of these bones are very difficult to immobilize, splints and bandages are poorly tolerated, and splints and bandages can actually increase fracture displacement, worsen fractures, and jeopardize neurovascular bundles. Key management principles are to provide adequate analgesia (See Chapter 16) and minimize movement to the maximal extent (kennel confinement except for limited leashed walks, using ancillary support).

- **HCPs without advanced orthopedic training and experience** generally should not attempt to immobilize fractures of the humerus, scapula, or femur.[1,2]
- **HCPs with advanced training and experience in orthopedics** (typically orthopedic surgeons, orthopedic PAs, splint technicians in Level 2 or higher facilities) may be capable, with written and/or verbal guidance from supporting veterinarians in constructing an appropriate Spica splint for humerus and femur fractures. In these instances, appropriate coaptation is safe, makes the patient more comfortable and consequently makes it easier and safer to transport a wounded MWD. With appropriate coaptation, the MWD is less likely to become agitated or aggressive every time it is bumped, moved, or moves about during manipulation and transport.

Open Fractures

Proper management of open fractures is essential. Open fractures should be treated as a medical emergency, once more pressing problems are addressed (See Table 18).[1,2]

Initial management of open fractures during resuscitation. While evaluating the entire patient and initiating life-saving therapy, take measures to protect the open fracture site:

- Do not attempt to reduce bone(s) protruding at fracture sites, as this drags contamination to the fracture site and may cause injury to the neurovascular bundle.
- Quickly remove any large gross contaminants from the wound (e.g., leaves, rocks, stick fragments), but do not attempt to clip the hair or cleanse the wound at this point.
- Cover the fracture and wound with sterile non-adherent dressing and apply a light bandage. This bandage should not be placed in an attempt to stabilize or immobilize the fracture at this time; it is simply to protect the open wounds and exposed bone from further contamination during initial patient resuscitation.

Specific management recommendations for open fractures. MWDs with open fractures generally will require surgical correction of the fracture once evacuated to veterinary facilities. The overriding aims are to prevent bacterial infection and promote normal healing.

- Culture open fracture sites as soon as possible after presentation and before antibiotic use if possible.
- Administer antibiotics as per Table 20 in Chapter 14, focusing on use of intravenous antibiotics based on

(Continued on page 93)

likely contaminants. Never withhold antibiotic therapy in any patient with an open fracture.

- Address pain with appropriate analgesic therapy (See Chapter 16). Reassess pain every 4-6 hours.
- Manage soft tissue injuries over the fracture site appropriately, as proper management of the wound postures the patient for successful outcome. See Chapter 14 for wound management recommendations.
- After appropriate wound care, apply a sterile moisture-retentive bandage over open fractures, as it is important to keep soft tissues and bone moist for optimal healing. Change bandages at least once daily, based on degree of strike-through, soiling, or loosening.

TABLE 18. MANAGEMENT OF LONG BONE FRACTURES IN MWDS[1,2]

1. Address life-threatening problems first!

During resuscitation, protect any open fractures.

- Do not attempt to reduce bones protruding at the fracture site.
- Remove any large gross contaminants from the wound, such as leaves, rocks, or stick fragments, but do not clip hair or cleanse the wound at this point.
- Cover the fracture and wound with sterile non-adherent dressing and apply a light protective bandage.

2. LOWER LIMB FRACTURES -- After resuscitation, immobilize fractures or joint abnormalities involving the limbs below the elbow or knee, prevent bacterial infection, provide analgesia, and promote normal healing until definitive surgical repair.

- Culture any open fracture sites as soon as possible, and before antibiotic use if possible.
- Administer antibiotics as directed in Chapter 14 for open fractures.
- Manage any open wounds over the fracture site as per Chapter 14.
- Provide analgesia as directed in Chapter 16. Reassess pain every 4-6 hours.
- Apply splints or heavy bandages to immobilize the fracture site, ensuring the joints above and below the fracture site are immobilized.

3. UPPER LIMB FRACTURES – After resuscitation, minimize further injury to fractures of the limbs above the elbow or knee.

- Culture any open fracture sites as soon as possible, and before antibiotic use if possible.
- Administer antibiotics as directed in Chapter 14 for open fractures.
- Manage any open wounds over the fracture site as per Chapter 14.
- Provide analgesia as directed in Chapter 16. Reassess pain every 4-6 hours.
- Unless experienced in external coaptation, DO NOT apply splints or heavy bandages, as these are poorly tolerated by MWDs and will increase the risk of displacement and further injury to the neurovascular bundle.
- Confine the MWD to a kennel or small space; limit walks; and support as needed when walked.

4. Monitor MWDs with fractures.

- Ensure a device is used to prevent self-trauma (See Chapter 2).
- Assess pain frequently and ensure adequate analgesia.
- Change splints or bandages daily (open fractures, wounds, soiled or wet) or every other day (clean and dry splints or bandages that do not cover open fractures or wounds).

- Apply splints and bandages as described previously for open fractures of the radius/ulna or tibia, or lower aspects of the limbs. Confine MWDs with any fracture, but especially with upper limb fractures that cannot be immobilized.

Definitive Long Bone Fracture Repair

Definitive repair should be delayed until the patient can safely undergo anesthesia and surgery performed by veterinary personnel best equipped to manage MWD's post-operatively. There is no role for HCPs to attempt definitive repair of long bone fractures in MWDs. Standard practice human fracture management is to span the fracture with external fixation to stabilize during transport, with definitive repair at a later date. Spanning the fracture is not considered definitive repair, but is not appropriate for MWDs as they will be ambulatory and break the construct. Thus, temporary external skeletal fixation is not indicated in MWD long bone fractures. The goals for HCP care of MWDs are initial management, stabilization, and evacuation to veterinary medical personnel for definitive care.

Pelvic Fractures

Pelvic fractures in MWDs in deployed settings will most likely be due to crush or blast injury (See Chapter 12). Evaluate the pelvis for external evidence of trauma or deformity.

The major joints involving the pelvis are the coxofemoral (hip) and sacroiliac (lower back) joints. Fractures or dislocations of these bones and joints are fairly common. A tip off for joint dislocation is asymmetry. Carefully palpate the hip joints and lower back for swelling, pain, or deformity that suggests joint injury. Move the limbs carefully through their range of motion while palpating the hip area and lower back to evaluate hip luxation.

Trauma to adjacent structures such as the rectum, descending colon, urinary bladder, urethra, and reproductive organs is a concern. Evaluate the inguinal area and external genitalia for evidence of trauma or herniation. Fractures of the pelvic floor commonly cause asymmetry, swelling, and bruising in the inguinal region. Hidden internal injury due to fractures (e.g., urethra, urinary bladder, prostate, vagina) is difficult to detect. Assess neurologic input to the anus by pinching the skin around the anus with hemostatic forceps—the expected response is sudden tightening of the anal sphincter.

Examine external genitalia for trauma. Carefully perform a digital rectal exam with a well-lubricated finger to assess for bleeding and injury to the urogenital structures in the pelvic canal, and to palpate for pelvic fractures.

Manage pelvic fractures by confining the MWD to its kennel or to a small space, limiting movement to short, frequent, handler-controlled leash walks using a towel or other material passed beneath the abdomen to provide support when walking, and adequate analgesia (See Chapter 16).

Long Bone Fracture References

1. Halling K. Wounds and open fractures. In: Mathews K, ed. *Veterinary Emergency and Critical Care Manual.* Guelph, Ontario, Canada: Lifelearn, Inc., 2006;702-708.

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CHAPTER 14

Wound Management

Open Wounds and Necrotic Tissue

MWDs with wounds are frequently presented for care. Wounds commonly result from ballistic injuries, bites, motor vehicle trauma, or other trauma. In most cases, traumatic wounds can be classified as contaminated or dirty/infected wounds; the difference is based on how long the wound existed before presentation. Contaminated wounds generally are considered those less than 6 hours old, and dirty/infected wounds are considered those greater than 6 hours old and generally with obvious exudates or infection. Wounds are often noted in conjunction with potentially life-threatening injuries; thus, in all MWDs presenting with wounds, a detailed systematic triage examination and a careful search for – and management of – more severe concurrent injuries must take precedent over management of wounds. In all instances, wound care follows resuscitation and stabilization of the patient.

Considerations in Wound Management

The primary goal in wound management is to create a healthy wound bed, one that has adequate blood supply to support repair, and without contamination or necrotic tissue that will impede healing and increase the risk of infection. Unless simple and small, many wounds will require frequent evaluation, generally at least once daily, based on location, extent, severity, and other factors. Many wounds will need to be managed as open wounds (although protected by bandages until smaller) before definitive surgical repair. The steps in daily wound evaluation are to assess the response to or need for antibiotics, debride dying or necrotic tissues and lavage the wound, assess for surgical closure, and protect the wound.

Initial Wound Management Recommendations

Provide effective analgesia or anesthesia based on wound severity, location, and other factors (See Chapter 16 and Table 19).[1-6]

1. Apply sterile water-soluble lubricant liberally to the wound bed and then clip the hair generously around the wound. Gently cleanse the skin around the wound, but not the wound bed, with surgical scrub. Gently lavage the lubricant and gross contaminants from the wound using sterile saline or lactated Ringer's solution (LRS); do not use tap water except in very grossly contaminated wounds with large amounts of debris, in which case it may be more expedient to flush the wound with warm water under gentle pressure initially. The goal of initial lavage is to remove gross contaminants and reduce the bacterial burden.

2. Debride grossly necrotic tissues and non-viable tissue carefully using aseptic technique and sharp dissection. Do not mass ligate tissues or use cautery excessively, as this usually leads to necrosis of these tissues

and serves as a bed for infection. Use caution not to damage, transect, or ligate major blood vessels (unless actively hemorrhaging) or nerves, as these are crucial to maintain effective blood flow and innervation distally.

3. Lavage of the wound is necessary to remove particulate debris and reduce bacterial contamination – remember the adage, ***"The solution to pollution is dilution."***

   - There are several devices acceptable and available for adjunctive wound irrigation. Simple bulb irrigation and gravity irrigation have been the preferred method of wound irrigation. The bulb and syringe method has been more widely accepted and is significantly less expensive. Large bore gravity-run tubing has been favored for quick irrigations. Pulsatile jet lavage irrigation using a battery powered system is another method of adjunctive irrigation in the overall management of contaminated crushed wounds. It must be emphasized that all methods of wound irrigation, including pulsatile lavage, are adjuncts to sharp, surgical debridement and not a substitute for surgical debridement.

   - Normal saline, sterile water and potable tap water all have documented similar usefulness, efficacy and safety. Sterile isotonic solutions are readily available and remain the fluid of choice for irrigation. If unavailable, sterile water or potable tap water can be used.

   - Bacterial loads drop logarithmically with increasing volumes of 1, 3, 6, and 9 liters of irrigation. The current recommendations are as follows: 1-3 liters for small volume wounds, 4-8 liters for moderate wounds, and 9 or more liters for large wounds or wounds with evidence of heavy contamination.[3]

4. Generally, contaminated and dirty/infected wounds should not be sutured until healthy granulation tissue is established, which generally occurs in 3-5 days. This is especially true for bite wounds.

Bandaging Recommendations

- In nearly all cases, open wounds should be bandaged to protect the wound from contamination and support the wound while it heals. In most cases, mechanical debridement is desired (i.e., in most wounds after initial management has been performed, with varying degrees of contamination or infection), so use an adherent dressing. Once a healthy granulation bed has formed, convert to a non-adherent dressing.

- The most common adherent dressing is a wet-to-dry bandage, consisting of sterile gauze sponges that are saturated with sterile saline, gently wrung to eliminate excessive moisture, and the applied directly to the wound. Over the wet dressing, several dry gauze sponges are applied. In large wounds, laparotomy sponges may be optimal to cover more wound bed.

- The most common non-adherent dressing is a semi-occlusive cotton pad (e.g., Telfa®) that retains moisture against the wound bed and 'wicks' exudate from the surface of the wound.

- Use topical silver sulfadiazine ointment or triple-antibiotic ointment on most wounds.

- Apply a secondary layer over the primary layer. Most commonly, rolled cast padding or roll cotton is used to provide support. Splints can be included in the secondary layer, if used.

- Apply a tertiary layer, typically consisting of non-adherent conforming bandage, adhesive bandage, or both. This layer holds the dressing and secondary layer in place, provides additional support, and provides more durable protection of the underlying layers. In most cases, the tertiary layer is applied just tight enough to hold the bandage in place, and without compression.
- Change bandages at least once daily. More frequent bandage changes may be necessary if the wound has a heavy discharge or the bandage becomes soiled or partially removed by the MWD. Once wound discharge is reduced and a healthy granulation bed has formed, bandage changes become less frequent, generally every 2-3 days.
- Any MWD with a bandage applied must be prevented from chewing at the bandage. A plastic bucket with the bottom cut out can be used to prevent self-trauma can be attached to the dog's collar as an effective prevention practice (See Figure 21 and Figure 22).
- Negative pressure wound therapy (NPWT; e.g., WoundVac®) has proven a viable treatment modality for wounds in dogs, but requires proper training to apply properly to dogs and frequently heavy sedation of the MWD to prevent disruption of the dressing. HCPs with experience with NPWT are encouraged to consult with supporting veterinary personnel if this treatment modality is considered necessary before the MWD is evacuated to a veterinary facility. In most cases, application of NPWT can be delayed until the MWD is evacuated to a veterinary facility for long-term care.
- A "tie-over" bandage should be used in locations that are difficult to place a bandage, such as the inguinal area, dorsum, hip, and flank. Routine bandages placed in these areas typically slip off, and fail to protect the wound. A tie-over bandage consists of the same layers of bandage material, whether adherent or non-adherent, placed within and over the wound in a packing fashion. Multiple suture loops are placed around the periphery of the wound in the skin, evenly spaced around the wound, using large (2-0 or larger) monofilament suture material. The wound is then covered with a portion of impermeable drape or similar material. The bandage is then secured using umbilical tape or similar material laced through the suture loops (see Figure 44). Ties of surgical masks are a good substitute if umbilical tape is not available. The ties should be sufficiently tight to hold the bandage in place, with mild tension on the suture loops. The covering layer should be snug over the top of the underlying layers. A tie-over bandage will not have a compression layer.

Figure 44. Tie-Over Bandage.

Antibiotic Use with Open or Necrotic Wounds

Systemic antibiotics are indicated for any MWD with moderate or severe wounds. Wound cultures are indicated at admission if the patient presents with a dirty/infected wound, if obvious infection develops during any phase of wound management, if the wound fails to heal normally, or if systemic signs of infection develop. Continue antibiotics for a minimum of 7 days (See Table 20).

TABLE 19. MANAGEMENT OF OPEN OR NECROTIC WOUNDS IN MWDS[1-6]

1. Manage potential local and systemic infection.

a. Collect samples for microbial culture and sensitivity testing, preferably before antibiotic therapy is started. Transfer samples to supporting veterinary personnel for submission.

b. Initiate antibiotic therapy within the first 6 hours of the wound's development, or as soon as possible thereafter (See Table 20 for antibiotic selection and dosing).

c. Culture the wound if obvious infection develops during any phase of wound management, if the wound fails to heal normally, or if systemic signs of infection develop.

2. Provide initial wound management.

a. Provide effective analgesia or anesthesia based on wound severity, location, and other factors (See Chapter 16).

b. Apply sterile water-soluble lubricant to the wound bed and then clip the hair generously around the wound.

c. Gently cleanse the skin around the wound, but not the wound bed, with surgical scrub.

d. Gently lavage the lubricant and gross contaminants from the wound using sterile saline or lactated Ringer's solution (LRS).

e. Debride grossly necrotic tissues and non-viable tissue carefully using aseptic technique and sharp dissection.
   1) Do not mass ligate tissues or use cautery excessively.
   2) Do not damage, transect, or ligate major blood vessels (unless actively hemorrhaging) or nerves, as these are crucial to maintain effective blood flow and innervation distally.

f. Lavage the wound to remove particulate debris and reduce bacterial contamination.
   1) Thoroughly lavage the wound bed.
   2) Lavage under pressure.
   3) Sterile isotonic solutions are the fluid of choice.

g. Bandage the wound.
   1) Apply a primary layer to provide mechanical debridement initially, using a wet-to-dry bandage, consisting of sterile gauze sponges saturated with sterile saline, gently wrung to eliminate excessive moisture, and applied directly to the wound.
   2) Apply several dry gauze sponges over the primary layer.
   3) Apply a secondary layer over the primary layer, using cast padding or roll cotton +/- splints to provide support.
   4) Apply a tertiary layer of non-adherent conforming bandage, adhesive bandage, or both, using light compression.
   5) Apply a "tie-over" bandage in areas that are not amenable to routine bandaging.

3. Provide daily wound care until evacuation, using appropriate analgesia, sedation, or anesthesia. Change bandages at least once daily, but more frequently if heavy discharge is present or the bandage is soiled or partially removed by the patient. Lavage the wound as above at every bandage change. Debride the wound as above at every bandage change. Apply a new bandage as above; however, change the primary layer to a non-adherent dressing once a healthy granulation bed is formed.

TABLE 20. ANTIBIOTIC SELECTION AND DOSING FOR MWDS			
Antibiotic	**Dose for MWD**	**Route**	**Frequency**
Amoxicillin	20 – 30 mg/kg	PO	q 12 h
Amoxicillin-Clavulanic Acid	13.75 mg/kg	PO	q 12 h
Ampicillin	20 – 30 mg/kg	IV	q 8 h
Ampicillin Sulbactam	20 – 30 mg/kg	IV	q 8 h
Cefazolin	20 -30 mg/kg	IV	q 8 h
Cefotaxime	22 mg/kg	IV	q 8 h
Ceftriaxone	25 mg/kg	IV	q 8-12 h
Cephalexin	30 mg/kg	PO	q 12 h
Ciprofloxacin	35 mg/kg	PO	q 24 h

Wound Management References

1. Garzotto CK. Wound management. In: Silverstein DC and, Hopper K, eds. Small Animal Critical Care Medicine. St. Louis: Saunders/Elsevier, 2015;734-743.
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5. Balsa IM, Culp WT. Wound Care. In: Veterinary Clinics of North American: Small Animal Practice 2015;45:1049-65.
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Ocular Injuries

Ocular injuries in MWDs in deployed settings will likely include irritant conjunctivitis, corneal ulceration, eyelid lacerations, and penetrating foreign objects. Clinical signs of ocular and periocular injury include eyelid lacerations, swelling of the periorbital tissues or conjunctiva, exudate in the conjunctival sac or on the eyelids, blepharospasm, intense redness of the conjunctiva, epiphora, photophobia, and rubbing the eye. Penetrating foreign objects may be present.

Evaluations of Ocular Injuries

1. Sedate the MWD as needed to allow detailed but safe examination of the affected eye (See Chapter 16).
2. Flush the affected eye and adjacent tissues with copious amounts of sterile saline or ophthalmic rinse.
3. Topically anesthetize the affected eye to facilitate examination, using 3-4 drops of topical ophthalmic anesthetic solution (e.g., proparacaine) on the cornea.
4. Remove exudate from the affected eye, if present, using saline-soaked cotton balls.
5. Examine the conjunctival area for foreign objects (e.g., particles, grass, plant seeds, thorns).
6. Stain the cornea of any affected eye using fluorescein stain to evaluate for ulceration.
7. Apply stain to the cornea, allow stain to dwell for at least 1 minute, and then rinse copiously with sterile saline or ophthalmic rinse.
8. Examine the eyes for symmetry, anisocoria, abnormal PLRs, or lens abnormalities.
9. While specific treatment of these problems is beyond the scope of practice for HCPs, the presence of these findings may suggest additional injury (e.g., TBI), that may need to be managed by the HCP.
10. Apply a bucket to the dog's collar to prevent self-trauma in ALL cases of ocular or periocular injuries in MWDs until the problem has resolved (See Figure 21 and Figure 22).

Treatment of Ocular Injuries

1. Irritant conjunctivitis

- Noted by varying degrees of conjunctival hyperemia, mild-to-moderate chemosis, and absence of other ocular signs.
- Flush eye and adjacent tissues with sterile saline/ophthalmic rinse 1-2 times daily.

- Apply bland ophthalmic antibiotic ointment (preferable) or solution (e.g., bacitracin-neomycin-polymyxin), q8h for 5 days.
- If corneal ulceration is present, DO NOT USE topical corticosteroids, as the risk of worsening the ulcer is high.
- If corneal ulceration is not present, the ophthalmic ointment can include topical corticosteroids. The eye MUST BE examined daily and fluorescein stain applied daily to ensure ulceration has not developed. Discontinue use of topical ophthalmic corticosteroids if any evidence of corneal ulceration is noted.

2. Corneal ulceration

- Noted by varying degrees of conjunctival hyperemia, mild-to-moderate chemosis, and presence of fluorescein dye uptake on the affected cornea.
- Flush eye and adjacent tissues with sterile saline/ophthalmic rinse 1-2 times daily.
- Apply bland ophthalmic antibiotic ointment (preferable) or solution (e.g., bacitracin-neomycin-polymyxin), q8h for 5 days.
- DO NOT USE topical corticosteroids, as the risk of worsening the ulcer is high.

3. Penetrating or embedded foreign object.

- Noted by the presence of a foreign object on the surface of or embedded in or through the cornea, with varying degrees of corneal edema. If the injury is chronic, neovascularization of the cornea may be present.
- Flush the eye and adjacent tissues with copious amounts of sterile saline/ophthalmic rinse 1-2 times daily.
- If the object is on the surface of or embedded on the outer cornea, attempt cautious removal after topically anesthetizing the eye.
    - If the object is removed, apply topical bland ophthalmic antibiotic ointment (preferable) or solution (e.g., bacitracin-neomycin-polymyxin) to the affected eye, q8h for 5 days.
    - DO NOT USE topical corticosteroids, as the risk of worsening the injury is high.
- If the object cannot be removed from the surface of the cornea, or appears to penetrate the cornea or globe, do not attempt to remove the object.
    - Apply topical bland ophthalmic antibiotic ointment (preferable) or solution (e.g., bacitracin-neomycin-polymyxin) to the affected eye, q8h for 5 days.

- DO NOT USE topical corticosteroids, as the risk of worsening the injury is high.
- Do not attempt to bandage the eye/head. The anatomy of the canine head is such that attempts to bandage the eye generally are unsuccessful and bandages tend to worsen ocular injuries. Although it is counterintuitive, leave the affected eye unbandaged.
- Evacuate the MWD to a veterinary facility on an URGENT basis once feasible.

4. Eyelid and peri-orbital lacerations.

- Noted by the presence of lacerations or abrasions affecting the peri-orbital tissues.
- Deeply sedate or anesthetize the MWD (See Chapter 16).
- Close subcutaneous tissues in 1 or 2 layers, using absorbable 3-0 or 4-0 monofilament simple interrupted sutures.
- Close the skin using nonabsorbable 3-0 nylon.
- Apply topical bland ophthalmic antibiotic ointment (preferable) or solution (e.g., bacitracin-neomycin-polymyxin) to the affected eye, q8h for 5 days.

Ocular Injury References

Hollingsworth, SR and Holmberg, BJ. Ocular disease in the intensive care unit. In: Small Animal Critical Care Medicine, Silverstein DC and Hopper K, eds. Saunders/Elsevier, St Louis, MO, 2015;815-820.

Analgesia and Anesthesia

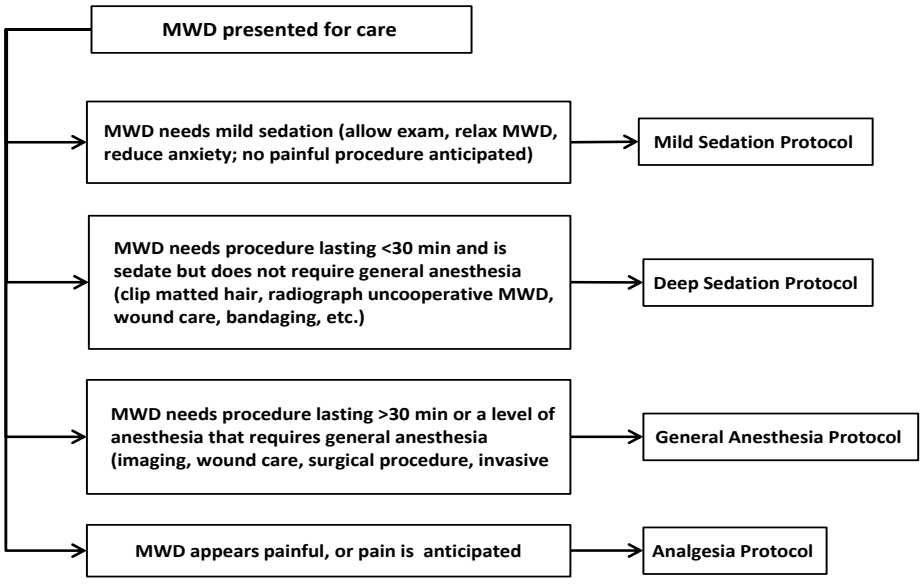
This chapter provides succinct, quick reference protocols for analgesia and anesthesia of emergently ill or injured MWDs, using simple combinations of drugs readily available to most HCPs.[1] A decision-making algorithm is provided below (Figure 45) to determine which analgesia or anesthesia protocol is recommended, based on specific need. Before any use of analgesia or anesthesia, a full physical exam must be performed.

MWDs can be fractious and difficult to manage, and often require heavy sedation for relatively simple procedures. Tailored protocols are provided, based on the level of sedation or anesthesia required – mild or deep sedation, or general anesthesia.[1]

Prehospital Analgesia

MWD handlers or combat medics may have given morphine, fentanyl, or ketamine before arrival, so inquire about drug use before transport, which may affect assessment of the patient's mentation and analgesia.

Figure 45. Decision-making Algorithm for Analgesia or Anesthesia.



Protocol Guidance

All drug combinations use the intramuscular (IM) route for ease and safety. If used within 5 minutes, all drugs can be combined in the same syringe to simplify administration. ***Wait at least 20 minutes after administration before attempting any procedure, to allow maximal drug effect***. Ideally, an IV catheter should be placed once feasible (See Chapter 2).

Drug Dosing in Dogs

Dosages for many analgesics in dogs are significantly higher than for people. Trust the doses provided in this chapter, and dose as directed to prevent inadequate analgesia or sedation and 'wind up' pain.

Gastrointestinal Side Effects of Opioids

Protocols include opioids, which in dogs typically causes emesis, often within 5 minutes of administration. Use caution and have the handler prepared to remove the muzzle to minimize aspiration risk.

Mild Sedation Protocol

- Use to relax MWDs for examination, handling, or short minor procedures that will not cause pain. Use to reduce anxiety.
- **Protocol:** MIDAZOLAM 0.3 mg/kg IM and HYDROMORPHONE 0.2 mg/kg IM.
- **Expectations:** The MWD will be calm, but reactive and noise sensitive.

Deep Sedation Protocol

- Use for procedures that can be completed in <30 minutes and do not require general anesthesia, such as clipping of hair, wound cleansing, minor wound debridement, splinting of lower limb fractures, bandage application or removal, ear cleaning, or radiography. First-line protocol for fractious MWDs.
- **Protocol:** MIDAZOLAM 0.3 mg/kg IM and KETAMINE 5 mg/kg IM and HYDROMORPHONE 0.1 mg/kg IM.
- If deeper sedation or light anesthesia is necessary, or to allow general anesthesia induction, use PROPOFOL in 1 mg/kg boluses IV as needed.
- **Expectations:** The MWD will not be able to walk, cannot be intubated, can be aroused with stimulation, and maintains laryngeal and palpebral reflexes.

General Anesthesia Protocol

- Use to facilitate imaging, allow management of fractures, perform surgical procedures, and perform invasive diagnostic procedures.
- Preoxygenate for 5 minutes using oxygen mask.

- Premedicate using the Deep Sedation Protocol, and place an IV catheter.
- Induce using PROPOFOL 1 mg/kg IV boluses to effect.
- Intubate with an appropriate endotracheal tube. Most MWDs require a 9-11 mm ID endotracheal tube. Use a cuffed tube.
- Maintain anesthesia using ISOFLURANE 0.5-1.5% titrated to effect in 100% oxygen or SEVOFLURANE 2.0-2.5% titrated to effect in 100% oxygen or PROPOFOL CRI 100-300 mcg/kg/min.
- Manage pain with HYDROMORPHONE 0.1 mg/kg IV boluses, not to exceed 0.2 mg/kg per hour.
- Monitor appropriately, give IV fluids, and keep the MWD warm (See **Ancillary Support** in this chapter, and Table 21 on the next page).

Effective Analgesia Protocols for MWDs

Assessment of pain in dogs is difficult. Dogs are generally very stoic and often hide or fail to show outward signs of pain. HCPs should err on side of providing analgesia – if performed properly, it is safe and effective, and analgesia is critically important for safe handling and alleviation of pain.

- Note that all protocols have analgesia incorporated into them. Additional analgesia can be provided by the IV, IM, or PO route, as necessary.
- ***Scheduled administration of analgesics in the post-procedure period is preferred*** to as needed administration in dogs, because pain can be difficult to assess and to avert the 'roller coaster' effect of unmanaged pain.
- For intermittent IV or IM supplementary analgesia, use one of the following drugs:
  - HYDROMORPHONE 0.1-0.2 mg/kg q2-4h.
  - MORPHINE 0.2-0.5 mg/kg q4-6h
- For CRI supplementary analgesia, use one of the following drugs:
  - FENTANYL 2-10 mcg/kg/h.
  - MORPHINE 0.1-0.25 mg/kg/h.
  - HYDROMORPHONE 0.02-0.05 mg/kg/h.
- For PO supplementary analgesia, use TRAMADOL 5-10 mg/kg PO q8-12h for up to 5 days.

Caution: Do NOT use acetaminophen or ibuprofen in MWDs, as these drugs can cause liver toxicity. AVOID use of NSAIDs such as naproxen, meloxicam, and aspirin in emergently ill or injured MWDs.

Opioid Reversal

At appropriate doses, dogs appear less susceptible to opioid-induced respiratory depression and excessive sedation. However, opioid side effects can be reversed in the dog using NALOXONE 0.01-0.02 mg/kg slow IV to effect if needed. Note that this will reverse analgesia as well as sedation!

Ancillary Support

- Any MWD that is deeply sedated or under general anesthesia should be given IV crystalloid fluid therapy at 10 mL/kg/h to offset anesthesia-induced hypotension. Additional fluid volumes may be necessary based on the underlying problem (e.g., shock should be given IV fluids to targeted endpoints, as per Chapter 6, Figure 33).
- Active warming should be provided for any MWD that is deeply sedated or under general anesthesia. Use forced-air warmers, warm water circulating blankets, heat-retaining covers, and warming tables to target a body temperature of 100-101° F. Monitor temperature post-procedure until sustained >100^0 F.
- Basic and advanced monitoring of the MWD at a level considered appropriate for a human patient for the respective level of analgesia or anesthesia must be provided. Table 21 lists key monitoring parameters and goals for anesthetized MWDs, and common anesthesia machine settings.

TABLE 21. KEY MONITORING PARAMETERS & ANESTHESIA MACHINE SETTINGS

Parameter	Normal Values	Notes
Heart rate	60-100 bpm	See Chapter 2 for placement of ECG electrodes
Heart rhythm	Normal sinus	
Blood pressure	MAP >60 mmHg	Non-invasive technique
Pulse oximetry	97 ± 2%	See Chapter 2 for placement
Capnography	E_TCO_2: 35 – 45 mmHg	Up to 60 mmHg is permissible in a normoten-sive, spontaneously ventilating patient
Temperature	99 - 102.5 ^{0} F	Continuous recording probes can be inserted into the esophagus or rectum
Fresh gas flow	1 – 2 L/min	
F_IO_2	0.3 – 1.0 %	
Inhalant agent	Isoflurane: 0.5 – 1.5% Sevoflurane: 1.0 – 3.0 %	
Ventilation modes	Spontaneous (preferred) Volume controlled: TV=10-20 mL/kg Pressure controlled: PIP=1-25 cmH_2O BPM = 6-12 PEEP: 0 – 5 cmH_2O	

Analgesia and Anesthesia Reference

US Army Public Health Command, Veterinary Medical Standardization Board, Anesthesia and Pain Management Standards, 10 October 2013.

CHAPTER 17

Traumatic Brain Injury and Acute Spinal Cord Injury

Traumatic brain injury (TBI) and acute spinal cord injury (ASCI) are uncommon in MWDs. These injuries are often catastrophic, with poor long-term outcome. Caring for affected MWDs is daunting and can tax resources. However, some CNS injuries are recoverable, so efforts to evaluate MWDs with TBI and ASCI should be made to determine the severity of injury and potential for successful outcome. Anticipate these injuries in MWDs exposed to building collapses, blast, and ballistics injuries.

Acute Spinal Cord Injury

Assume ASCI is present in every MWD trauma patient until proven it is not present. Maintain a high index of suspicion! 40-50% of MWDs with ASCI have concurrent injury elsewhere that may be more life-threatening.[1] Focus on initial resuscitation and stabilization, but constantly consider potential neurological injuries. Excessive movement can cause a partial injury to become a permanent injury. Limit movement during the initial exam and treatment period to that which is absolutely necessary until a detailed neurological exam is performed.

Clinical Signs Suggesting ASCI

Clinical findings of bruising over any part of the spine; spinal instability, misalignment, crepitus or pain along the spine; presence of head injury or altered mentation or level of consciousness; or major trauma to other body systems are early tips that ASCI may be present.

Specific neurological signs that strongly suggest ASCI include loss of conscious proprioception, loss of superficial and deep pain, and loss of function (paresis or paralysis).

Lesion Localization

It is ideal to localize the segment of the cord affected. Determine if upper motor neuron (UMN) or lower motor neuron (LMN) signs are present.

- **UMN signs** are characterized by increased motor tone causing normal or exaggerated limb reflexes, normal to increased muscle tone, and decreased proprioception and decreased superficial and deep pain sensation in areas caudal to the lesion.
- **LMN signs** are characterized by flaccid or weak motor tone causing depressed limb reflexes and decreased muscle tone in areas caudal to the lesion.

With both UMN and LMN involvement, paresis or paralysis are possible.

- C1-C5 – UMN signs to all 4 limbs, possibly abnormal respiration (shallow or absent).
- C6-T2 – UMN signs to the hind limbs and LMN signs to the forelimbs.
- T3-L3 – UMN signs to the hind limbs with normal forelimbs.
- L4-S2 – LMN signs to the hind limbs with normal forelimbs.

Diagnostic Imaging

Radiographs, CT, or MRI are often necessary for definitive diagnosis in patients with fractures or dislocations to determine the site of injury. If these imaging modalities are available and the MWD can be managed without worsening possible injury, attempt imaging (See Chapter 20). Heavy sedation or anesthesia will be necessary (See Chapter 16).

General Management Considerations for Patients with ASCI

Goals are to reduce neurological deficit and prevent further loss of neurological function (See Figure 46).

- Follow guidance in this CPG for management of shock, hypotension, hypovolemia, hemorrhage control, and respiratory dysfunction. Be prepared to intubate patients that are not breathing or have depressed ventilation. Careful intubation using manual in-line stabilization (MILS) is essential to minimize further injury.
- If signs suggest ASCI are present and the MWD is NOT ambulatory, immobilize the MWD using a backboard (plywood sheet, plastic board, EMS backboard, etc.) to which the animal is taped, and sedate with or without analgesia as often as necessary to prevent unwanted patient movement due to anxiety and pain.
- If signs suggest ASCI is present and the MWD IS ambulatory or adequate immobilization is not possible (due to lack of sedative/analgesia or support devices or patient temperament), confine the MWD to a small area or kennel and prevent excessive movement until evacuated.
- Do NOT use nonsteroidal anti-inflammatory drugs (NSAIDs).
- Do NOT give corticosteroids to MWDs with ASCI, UNLESS the animal has no deep or superficial pain, is paralyzed, or the neurological condition deteriorates. If corticosteroids are given, use ONLY a SINGLE dose of methylprednisolone sodium succinate, IV, 30 mg/kg over 15 minutes.

Conservative Management of ASCI

Indications for conservative (non-surgical) treatment include patients that are ambulatory or paraparetic, and patients that have strong voluntary movement and peripheral pain sensation.

- Maintain enforced confinement, analgesia, and sedation as needed to minimize movement.
- Evacuate URGENTLY if feasible.

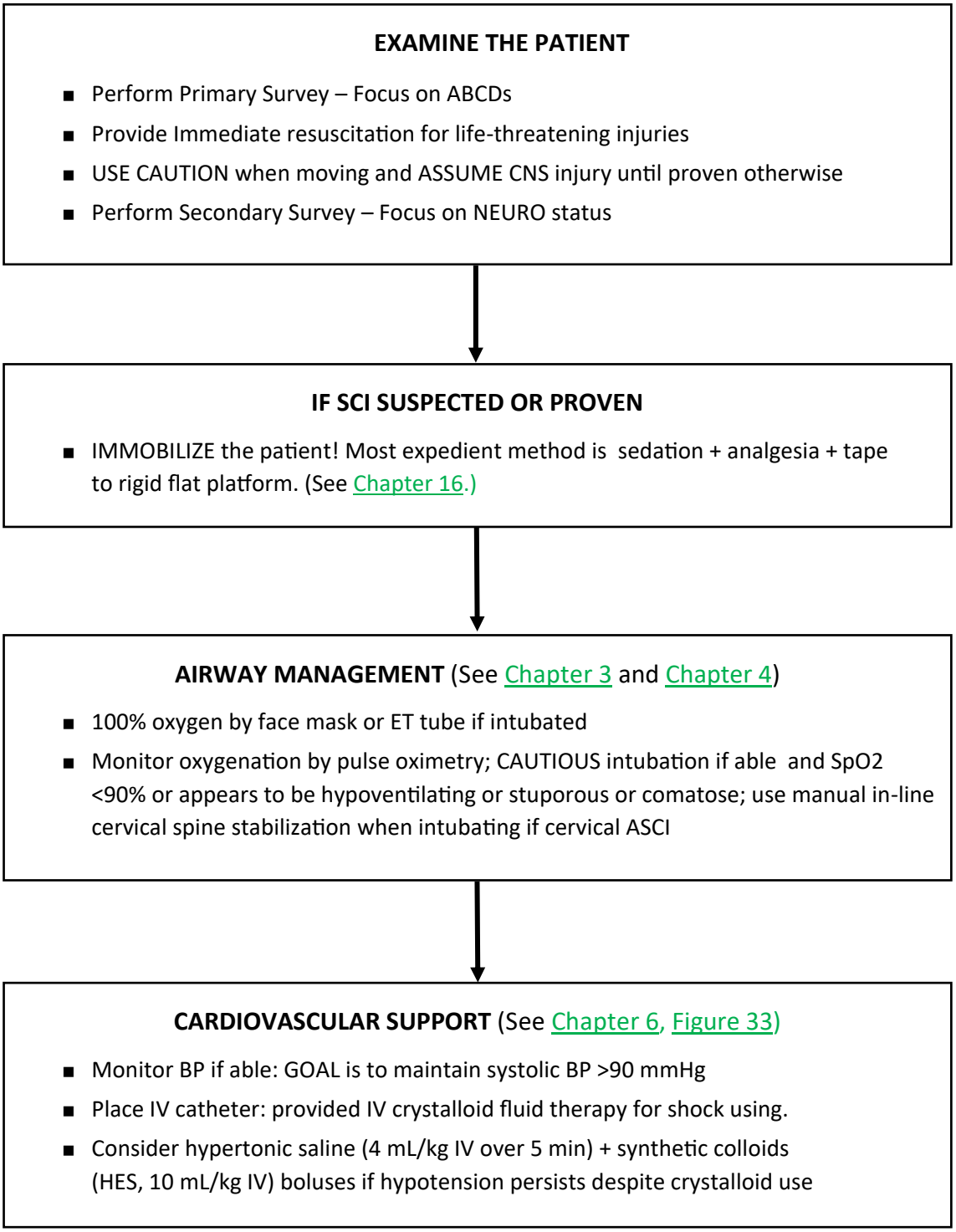
Surgical Management of ASCI

Early definitive surgical correction is indicated in non-ambulatory patients, patients with palpably unstable or displaced injuries, patients that deteriorate with conservative therapy, patients with peripheral pain sensation but no voluntary movements, and patients requiring decompressive surgery to correct displaced or fractured

spinal segments or bone fragments. Surgical management is likely not be feasible in a deployed setting.

- Definitive surgical repair of ASCI in MWDs should only be performed by qualified veterinary personnel.
- Evacuate as soon as feasible, or consider euthanasia (Chapter 21) if severe ASCI is present based on physical exam, diagnostic imaging results, lack of deep or superficial pain, or paralysis is present at any time.

Figure 46. Clinical Management Algorithm for Acute Spinal Cord Injury in MWDs.


EXAMINE THE PATIENT
Perform Primary Survey – Focus on ABCDs
Provide Immediate resuscitation for life-threatening injuries
USE CAUTION when moving and ASSUME CNS injury until proven otherwise
Perform Secondary Survey – Focus on NEURO status
IF SCI SUSPECTED OR PROVEN
IMMOBILIZE the patient! Most expedient method is sedation + analgesia + tape to rigid flat platform. (See Chapter 16.)
AIRWAY MANAGEMENT (See Chapter 3 and Chapter 4)
100% oxygen by face mask or ET tube if intubated
Monitor oxygenation by pulse oximetry; CAUTIOUS intubation if able and SpO2 <90% or appears to be hypoventilating or stuporous or comatose; use manual in-line cervical spine stabilization when intubating if cervical ASCI
CARDIOVASCULAR SUPPORT (See Chapter 6, Figure 33)
Monitor BP if able: GOAL is to maintain systolic BP >90 mmHg
Place IV catheter: provided IV crystalloid fluid therapy for shock using.
Consider hypertonic saline (4 mL/kg IV over 5 min) + synthetic colloids (HES, 10 mL/kg IV) boluses if hypotension persists despite crystalloid use

Traumatic Brain Injury

There is limited data on TBI in animals. Anticipate TBI in MWDs after trauma in 25-40% of cases.[2-6] TBI carries an extremely high mortality; assume a prehospital mortality of >40% in severe TBI cases. Management of MWDs is largely based on recommendations for treating people. Care by HCPs should be directed at efforts to mitigate secondary injury from hypotension, hyperthermia, hyper- and hypoglycemia, hypoxia, hyper-and hypocapnia, acid-base imbalances, electrolyte imbalances, SIRS, MODS, and ARDS. Thus, HCP care should be directed at maintenance of blood pressure, normoxemia, normal ventilation, and normal body temperature.

Clinical Signs Suggesting TBI

Brain injury should be suspected in any trauma patient with altered mentation (coma, stupor, depression, lethargy, inappropriate behavior or responses) or with physical evidence of head trauma (e.g., lacerations, abrasions, bruising, swelling, pain, bleeding from the nose or ears).

- Pay special attention to the patient's level of consciousness (LOC), overall pain response, pupillary light responses, cardiac and respiratory changes, motor activity and reflexes, and body temperature.
- The external ear canals and nasal openings should be examined for evidence of blood or CSF.
- The presence of lateralizing neurologic signs in a patient with brain injury suggests underlying intracranial hemorrhage; whereas patients with diffuse CNS deficits more probably have significant intracranial edema as a cause or contributor to their neurologic dysfunction.[2-5] These findings will affect treatment options.
- MWD posture on presentation may allow injury localization and estimation of prognosis. While these classic postures are not always noted, their presence can be used by first responders to identify severe TBI with poor-to-grave prognoses.
  - Patients with injury to the T2-L2 thoracic spine often display the Schiff-Sherrington syndrome (Figure 47, inset A), typically with normal mentation, forelimbs in extensor rigidity, and hind limbs that are flaccid. The prognosis for these patients is usually grave due to severe spinal cord trauma.
  - Patients with decerebellate rigidity (Figure 47, inset B) typically are obtunded or depressed, have

Figure 47. Characteristic Neurologic Postures on Presentation.

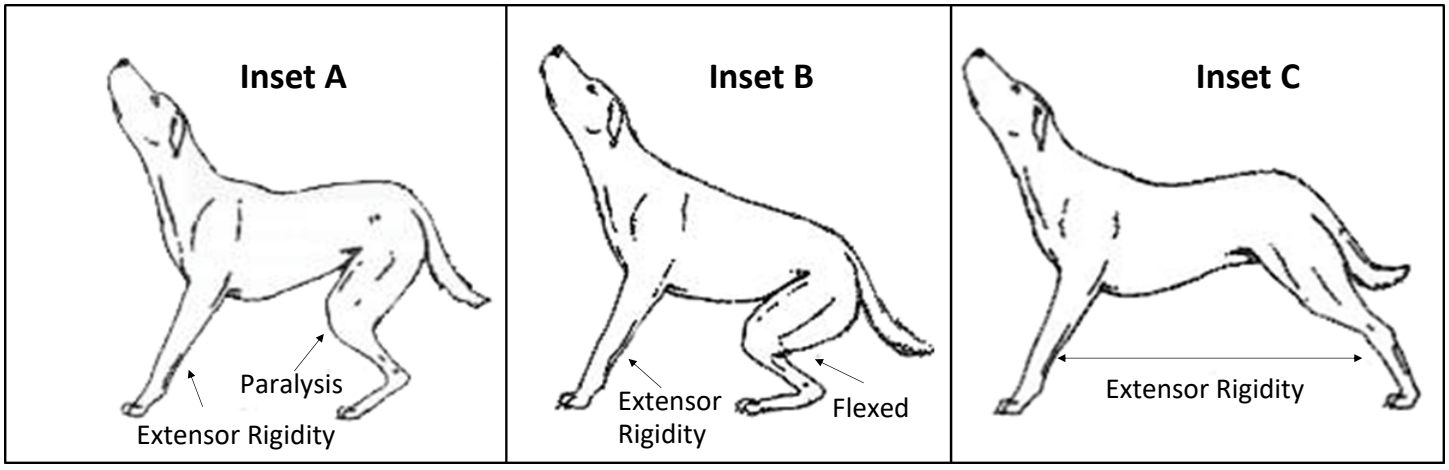


TABLE 22. MODIFIED VETERINARY GLASGOW COMA SCALE[7]	
Level of Consciousness	**Score**
Occasional periods of alertness and responsive to environment	6
Depression or delirium, capable of responding but response may be inappropriate	5
Stupor – semi comatose, responsive to visual stimuli	4
Stupor – semi comatose, responsive to auditory stimuli	3
Stupor – semi comatose, responsive only to repeated noxious stimuli	2
Comatose – unresponsive to repeated noxious stimuli	1
Motor Activity	
Normal gait, normal spinal reflexes	6
Hemiparesis, tetraparesis, or decerebrate activity	5
Recumbent, intermittent extensor rigidity	4
Recumbent, constant extensor rigidity	3
Recumbent, constant extensor rigidity with opisthotonus	2
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1
Brainstem Reflexes	
Normal PLRs and oculocephalic reflexes	6
Slow PLRs, normal to reduced oculocephalic reflexes	5
Bilateral unresponsive miosis, normal to reduced oculocephalic reflexes	4
Pinpoint pupils, reduced to absent oculocephalic reflexes	3
Unilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes	2
Bilateral unresponsive mydriasis, reduced to absent oculocephalic reflexes	1

opisthotonus, have fore limbs in extensor rigidity, and hind limbs in active flexion. These patients have a guarded prognosis due to severe injury to the cerebellum.

- Patients with decerebrate rigidity (Figure 47, inset C) typically are obtunded, have opisthotonus, and the fore limbs and hind limbs are in extensor rigidity. The prognosis for these patients is grave due to severe injury to the cerebrum.

Assessing Severity of TBI in MWDs

A modified veterinary Glasgow Coma Scale (Table 22 above) is validated for use in dogs.[7] Data is limited, however, correlating long-term outcome (i.e. prognostication) with initial or serial assessment of GCS in dogs.

- As with people, the lower the total GCS, the worse the TBI and the lower the expected survival with neurological function intact.
- Limited use in veterinary trauma patients has allowed development of suggested prognoses based on the MVGCS (See Table 23). HCPs should use this guidance when assessing severity of TBI and resource allocation.

TABLE 23. SUGGESTED PROGNOSES BASED ON MODIFIED VETERINARY GLASGOW COMA SCALE[7]	
MVGCS Score	**Suggested Prognosis**
3-8	Grave
9-14	Guarded
15-18	Good

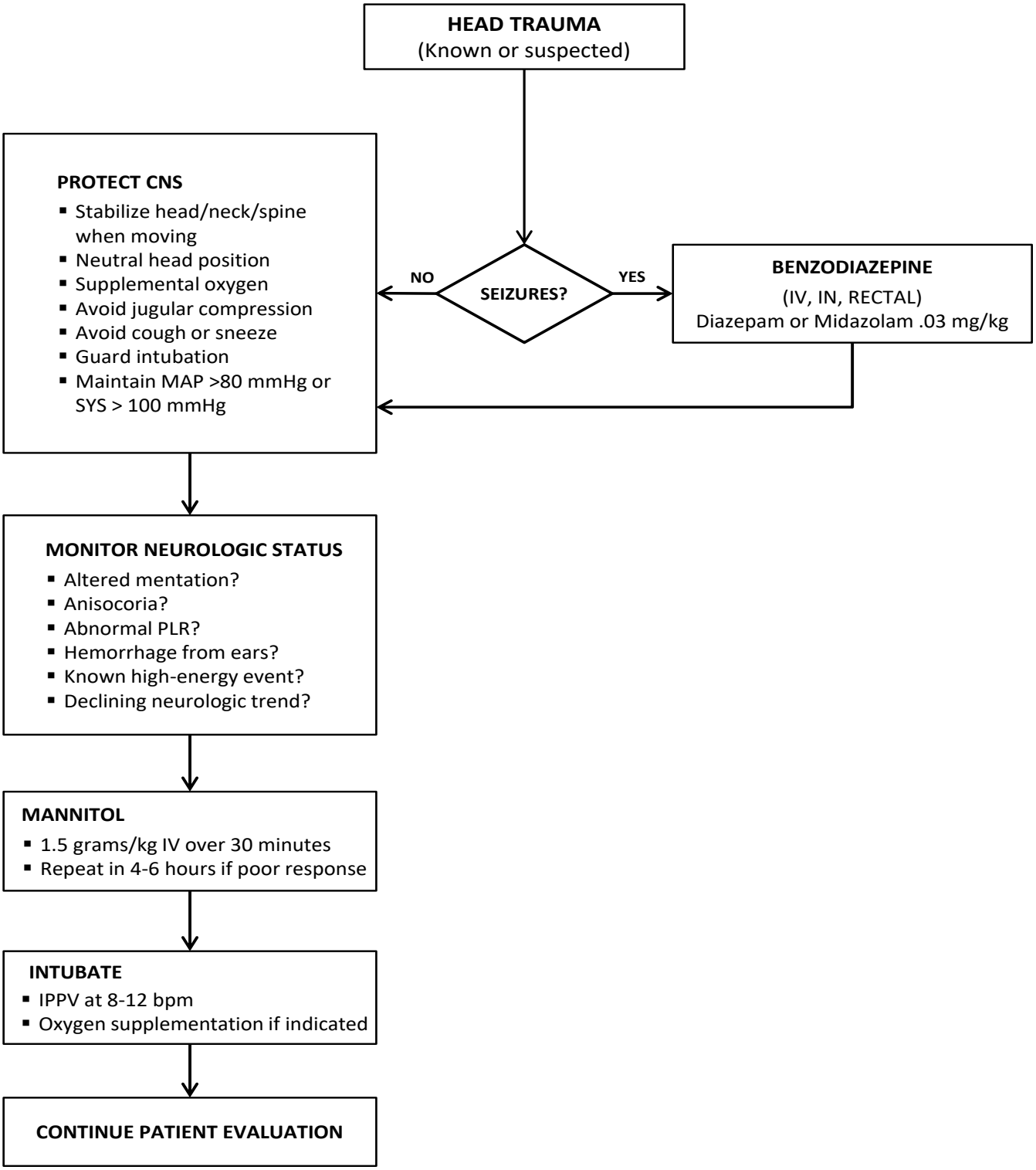
General Management Considerations for MWDs with TBI

It is critical to ensure adequate resuscitation and management of cardiovascular and respiratory problems, as hypotension, poor tissue perfusion, and hypoxia lead to progressive brain injury due to the adverse effects of secondary neurological injury due to ischemia, cerebral edema, reperfusion injury, and so forth. (See Figure 48 on the next page.)

- Follow guidance in this CPG for management of shock, hypotension, hypovolemia, hemorrhage control, and respiratory dysfunction.
- Be prepared to intubate patients that are not breathing or have depressed ventilation; careful intubation using manual in-line stabilization (MILS) is essential to minimize further injury.
- Focus care on preventing hypoxemia, maintaining cerebral perfusion pressure and systemic arterial pressure in the normal ranges, and preventing secondary ischemic cerebral injury.
  - Provide 100% oxygen by facemask. Monitor respiratory rate and effort. Be prepared to intubate and provide supplemental oxygen by ET tube. Maintain arterial carbon dioxide content in the normal range using assisted manual ventilation. Avoid hyperventilation!
  - Maintain normotension (MAP 70-80 mmHg or systolic BP >90 mmHg). Start IV crystalloid fluid therapy to correct shock and provide ongoing volume support (See Chapter 6, Figure 33). Measure blood pressure if possible; otherwise, guide fluid therapy based on presence or absence of distal pulses. Consider hypertonic saline (4 mL/kg IV over 5 min) or hyperoncotic fluid (HES, 10 mL/kg IV) boluses if hypotension persists despite crystalloid use.
  - Nurse with head elevated 30^0 with neutral neck position, avoid external jugular vein compression and catheters, avoid procedures that stimulate coughing or sneezing.
  - If evacuation will be prolonged and the patient is recumbent, rotate lateral recumbency and lubricate the eyes with ophthalmic ointment every 4 hours and maintain in a well-padded area.
  - If the MWD is conscious, restrict activity and movement (e.g., portable kennel), which may require sedation and analgesia (See Chapter 16).

(Continued on page 113)

Figure 48. Management Algorithm for TBI for MWDs.



- Give mannitol, 1.5 grams/kg, IV, over 30 min for MWDs with a MVGCS score of ≤ 8. Repeat this dose once more 4-6 hours after the first dose.
  Note that dogs are less likely to suffer subdural or intracranial hemorrhage; thus, mannitol should be used early in any MWD with moderate-to-severe TBI (MVGCS ≤ 8).
- ***Do NOT use corticosteroids to treat MWDs with TBI.***

Prognosis

HCPs must be realistic when treating MWDs with ASCI and TBI. While efforts and resources should be extended for MWDs with mild-to-moderate ASCI and TBI, HCPs should consider the likelihood of return to function. Consider euthanasia (See Chapter 21) for MWDs with catastrophic neurological injuries, or dogs with paralysis and that fail to respond to therapy or deteriorate despite care.

TBI and ASCI References

1. Park EH, White GA, Tieber LM. Mechanisms of injury and emergency care of acute spinal cord injury in dogs and cats. J Vet Emerg Crit Care 2012;22:160-178.
2. Dewey CW. Brain trauma. In: The Veterinary ICU Book. Teton NewMedia, Jackson, WY, 2003;910-920.
3. Finnie JW. Forensic pathology of traumatic brain injury. Vet Pathol 2016;53:962-978.
4. Fletcher DJ and, Syring RS. Traumatic brain injury. In: Small Animal Critical Care Medicine, Silverstein DC and Hopper K, eds. Saunders/Elsevier, St Louis, MO, 2015;723-727.
5. Sande A, West C. Traumatic brain injury: a review of pathophysiology and management. J Vet Emerg Crit Care 2010;20:177-190.
6. Sharma D, Holowaychuk MK. Retrospective evaluation of prognostic indicators in dogs with head trauma: 72 cases (January-March 2011). J Vet Emerg Crit Care 2015;25:631-639.
7. Platt SR. Coma scales. In: Small Animal Critical Care Medicine, Silverstein DC and Hopper K, eds. Saunders/Elsevier, St Louis, MO, 2015;422-425.

CHAPTER 18

Canine Post Traumatic Stress Disorder (C-PTSD)

Background

MWDs exposed to different types of intense external stimuli, such as explosions and gunfire, experience a syndrome that is similar to PTSD in people. While much remains unknown about this syndrome, most of the affected MWDs to date have been exposed to these stimuli in combat scenarios. Thus, it is reasonable that MWD handlers will seek medical guidance for acutely affected dogs from HCPs. It is essential to be aware of this syndrome and to effectively guide handlers in immediate care while working to evacuate affected dogs to veterinary facilities. Veterinary Corps Officers are the best resource for current diagnostic and therapeutic recommendations and will facilitate telemedicine consultation with experts at the DoD Military Working Dog Veterinary Service.

High Index of Suspicion

Maintain high index of suspicion based on antecedent events. HCPs should maintain a high index of suspicion for C-PTSD so as to identify potential MWDs for further evaluation. Inclusionary criteria in the immediate period include antecedent events, specifically any combination of the following:

- Concussive event (with or without physical injury)
- Exposure to a combat environment, and
- Prolonged or repeated deployment to combat zone.

Key Behavioral Signs Characteristic for C-PTSD

Specific behavioral signs are tip-offs that C-PTSD may be present. HCPs will need to rely on the MWD handler for information about these signs.

Signs include any combination of the following: escape or avoidance from work-related environments, increased or decreased reactivity to environmental or social stimuli, positive or negative changes in rapport with the handler, or interference with critical tasks (detection, controlled aggression, and obedience).
NOTE: Possible delayed onset or delayed reporting of clinical signs supporting C-PTSD is common.

Although MWD handlers will most likely seek guidance after acute onset of signs, HCPs should be aware some MWDs may not manifest obvious signs for some time, or handlers may not seek guidance until the syndrome is advanced. Additionally, some dogs will have been evaluated, with treatment initiated by veterinary personnel, with handlers seeking guidance some time later. Thus, other keys to C-PTSD for HCPs to be aware of are the continuance of behavioral signs for more than 30 days and failure to improve with time or treatment.

Rule Out Problems Mimicking C-PTSD

Some medical problems cause signs that mimic C-PTSD. HCPs should carefully evaluate dogs for exclusionary criteria, such as traumatic brain injury (See Chapter 17). A key tip-off that C-PTSD is likely not present is development of behavioral signs before the antecedent events noted previously. Veterinary personnel must rule out anecdotal reports and other appropriate behavioral diagnoses in order to validate a C-PTSD diagnosis.

Management Guidance for HCPS

Listen to the MWD handler! If a handler seeks guidance for his or her working dog due to abnormal behavior in the first 30 days after a traumatic event or combat action, HCPs should do the following:

1. Record the interaction and forward to supporting veterinary personnel (See Chapter 22).
2. Direct the handler immediately remove the dog from the situation, if not already done.
3. Upon approval from the supporting veterinary officer, provide an anxiolytic for dogs that have demonstrated a moderate-to-severe response, using one of the following agents, given PO (preferable), IV, or IM:
   - Clorazepate (TRANXENE®), 12.5 mg per dog PO q12h (moderate response)
   - Buspirone (BUSPAR®), 10-20 mg per dog PO q8-12h (moderate to severe response)
   - Alprazolam (XANAX®), 1-2 mg per dog PO q12h (moderate to severe response)
4. Direct the handler to provide support for the dog with social activity and play.
5. Direct the handler to provide work therapy by performing critical tasks in safe area, free from distress.
6. Recommend to the handler and the commander that the MWD not be used in the tactical environment until the dog has been evaluated by veterinary personnel.
7. Coordinate soonest evacuation to veterinary personnel for further evaluation and care, base on the tactical situation and resource availability. MWDs with C-PTSD should be classified as ROUTINE for evacuation planning purposes.

Long-term Management

There is no role for HCPs to attempt long-term or delayed management of presumed C-PTSD. Misdiagnosis and/or delay of appropriate treatment will equally jeopardize the affected MWD's proper therapy and potential of return to duty. Affected dogs should be evaluated under the supervision of Veterinary Corps Officers and through consultation with the DODMWDVS board-certified animal behaviorist. On-going research suggests a positive association with early diagnosis, +/- medication and focused desensitization/ counterconditioning performed by the MWD handler in the first 60-90 days of case management. Every attempt is made to return the MWD to duty and avoid unnecessary STRATEVAC/redeployment, which can result in security and readiness issues.

C-PTSD References

1. Overall KL, Burghardt, WF. Report of the Blue Ribbon Panel on Post-Traumatic Stress Disorder in Military Working Dogs. Department of Defense Military Working Dog Veterinary Service, Lackland Air Force Base TX, 2011.

2. Burghardt WF, Broach, DR. Canine Post-Traumatic Stress Disorder (C-PTSD) in Military Working Dogs. American Veterinary Medical Association, San Antonio TX, 2016.

Training and Toxicoses in MWDs

MWDs are exposed to small quantities of select drugs and explosives, contained in specially-constructed containers called training aids. Training aid ingestion and toxicity are events unique to MWDs and working dogs employed by law enforcement agencies.

- Training aids that are of concern when ingested include nitrate-based explosives (TNT, water gel, dynamite, RDX , detonation cords, and C-4), smokeless powder, sodium and potassium chlorates, and drugs (marijuana, heroin, cocaine, and amphetamines).[1]
- Potential toxicity is a concern and it is plausible that HCPs will be presented with an MWD that has ingested a training aid and is or may become toxic.

Clinical Signs of Intoxication (by Agent)

MWD handlers will have critical knowledge of the agent to which an MWD was exposed, for training aid ingestion. Common agents used and associated clinical signs follow.

- **Nitrate/nitroglycerin-based explosives.** Ingestion may result in hypersalivation, severe CNS abnormalities (ataxia, incoordination, seizures, tremors), gastrointestinal irritation (nausea, vomiting), and methemoglobinemia (cyanosis, weakness, syncope, respiratory distress).
- **Smokeless powder explosive.** Ingestion may result in hypotension, CNS depression (ataxia, depressed mentation, incoordination), and methemoglobinemia (cyanosis, weakness, syncope, respiratory distress).
- **Potassium and sodium chlorate explosives.** Ingestion may result in methemoglobinemia (cyanosis, weakness, syncope, and respiratory distress), CNS abnormalities (ataxia, incoordination, and depressed mentation), gastrointestinal irritation (nausea, vomiting, abdominal cramping and pain, hemorrhagic diarrhea with melena or hematochezia), hematuria, hemoglobinuria, and renal and liver failure.
- **Marijuana/hashish.** Ingestion may result in altered mentation (disorientation), hallucinations (in the dog, typically manifested as vocalizing, useless scratching, hyperexcitability), nausea and vomiting, and respiratory distress.
- **Heroin.** Ingestion may result in bradycardia, respiratory distress, miosis, coma, and sudden death.
- **Cocaine and amphetamines.** Ingestion may result in restlessness, tachycardia, hyperexcitability, vocalization, excessive or unprovoked aggression, seizures, and mydriasis.

Treatment of Training Aid Toxicity[1]

If ingestion occurred ≤ 4 hours before presentation and the MWD is conscious and has normal CNS responses, induce vomiting.

- Apomorphine is the drug of choice to induce vomiting in the dog. MWD handlers are issued apomorphine in tablet form, which is generally available in 6 mg tablets. If available, place ¼ to ½ tablet into either conjunctival sac. Vomiting typically occurs in 5-10 minutes. Once vomiting has occurred, rinse residual apomorphine from the conjunctival sac.
- Apomorphine may be available in the HCP drug inventory as an injectable agent (10 mg/mL). If the injectable form is available, give 0.03-0.04 mg/kg IV. Emesis is typically evident within 5 minutes in most MWDs.
- An alternative is to give hydrogen peroxide orally if apomorphine is not successful or available. Give 1 mL per kilogram body weight of hydrogen peroxide 3% orally. Note that hydrogen peroxide is less successful than apomorphine.
- Do NOT use Syrup of Ipecac or salt, or try to induce vomiting manually. These methods are ineffective in the dog and risk intense gastrointestinal irritation in the dog, and bite wounds to the HCP.

If ingestion occurred >4 hours before presentation, or if the dog has abnormal mentation or is unconscious or seizuring, do not induce vomiting. In these cases, balance the benefit of gastric decontamination by orogastric lavage against the very real risk of aspiration pneumonia. If gastric lavage is elected, induce general anesthesia (See Chapter 16) and ensure a cuffed endotracheal tube is used. Lavage the stomach using repeated instillations of water at a dose of 10-20 mL/kg. Maintain the cuffed endotracheal tube until the MWD has regained a swallowing reflex.

The next critical step in management of any training aid toxicity is to administer activated charcoal.

- The dose for activated charcoal is 1.5 grams/kg PO. Most MWDs will ingest activated charcoal if the charcoal is mixed with canned food. If the MWD will not ingest the charcoal voluntarily, either have the handler syringe the slurry slowly orally or (if the MWD is anesthetized) give the slurry by orogastric tube. MWD handlers are issued Toxiban® with sorbitol and may have initiated therapy prior to presentation.
- Activated charcoal WITH sorbitol as a cathartic is preferred as the initial dose.
- Repeat activated charcoal once in 4-6 hours. This dose should not include sorbitol.

If seizures are present or develop, treat the MWD with a benzodiazepine.

- Give midazolam (0.3 mg/kg IV or IN) or give diazepam (0.3 mg/kg IV, IN, or per rectum).
- Repeat in 10-15 minutes if seizures persist or recur.

If methemoglobinemia is suspected or confirmed and deemed causing significant respiratory distress, treat with methylene blue (if available).

- The dose for methylene blue 1% in the dog is 1-2 mg/kg IV slow bolus.
- This dose can be repeated once or twice if respiratory distress persists.
- Methylene blue can cause severe Heinz body anemia in the dog, so monitor an HCT q6-8h if this drug is used.

Toxicoses in MWDs Reference

Bright PA. Military working dog training aids: toxicity and treatment. Air Force Occupational and Environmental Health Laboratory (AFSC), Human Systems Division, Brooks Air Force Base, TX, 1989;1-32.

Diagnostic Imaging

Diagnostic imaging of injured or ills dogs is frequently required for comprehensive patient evaluation. Veterinary facilities may not be equipped for imaging, or may be limited to plain radiography. Advanced imaging (e.g., MRI, CT) is often ideal, and veterinary facilities do not have these capabilities. This chapter provides guidance for HCPs with extensive training in the use of CT and MRI, when considering advanced imaging requirements, highlighting unique aspects when imaging dogs.

Computed Tomography vs Magnetic Resonance Imaging

CT is often superior to MRI and used for assessment of margins of osseous or mineralized structures compared to MRI. CT can assess soft tissue changes and differences fairly well by narrowing windows and levels under standard algorithms to see differences of attenuation of the x-rays, but cannot manipulate the soft tissues due to their molecular structure as MRI can in order to enhance or null their differences. Therefore, MRI is often far superior to CT at assessing for subtle changes within soft tissues due to the dramatic contrast enhancement. MRI is most often utilized in veterinary medicine and is the modality of choice when you are trying to assess soft tissue structures not easily accessed by an ultrasound probe or are looking for diseases that may not be appreciated via any other modality. MRI is used primarily for neurologic (brain and spine) imaging and joint imaging concerning cartilage, ligaments, and/or menisci. Keeping those general statements in mind, depending on the type of disease you are assessing for you may be able to appreciate the abnormalities on both modalities, so either study may be adequate for diagnosis. References are provided with specific imaging protocols for MWDs.[1-5]

Computed Tomography[3,4]

Sedation/Anesthesia

The patient must be either heavily sedated or anesthetized while the study is taking place. CT studies of the thorax and abdomen require general anesthesia and intubation of the patient, with closure of the pop-off valve on the anesthetic machine during image acquisition. Depending on how advanced the CT machine is and slice thicknesses needed, this may or may not be a problem for the patient, as the breath hold may have to last for several seconds. ***Always ensure anesthesia pop-off valves are not left closed, to avoid pneumothorax.***

Contrast Administration

Intravenous iodinated contrast may be used during a CT study in order to further enhance margins of soft tissue structures. If a CT is being conducted to assess an abnormal soft tissue mass or structure, intravenous iodinated contrast should be administered after acquisition of routine images prior to contrast administration for comparison purposes. This contrast administration allows for further characterization of the abnormal soft

tissue as only the vascular portions of the structure will enhance.

- The current standard for use of contrast during CT is non-ionic iodinated contrast media, with the two most common types being iohexol and iopamidol. Iohexol is most commonly used in MWDs. For a vial of iohexol at a concentration of 240mg/mL, the intravenous contrast dose is 400 mg/kg (rule of thumb is 1 mL of contrast agent per pound of body weight, not to exceed 60 mL).
- IV catheterization of the patient is required for contrast administration, and the contrast is a thick, sticky solution which needs to be bolused to the patient, so use 18 gauge catheters and syringe needles.
- After bolusing the contrast to the patient, only the study in the standard algorithm needs to be repeated.
- If the patient is dehydrated, the patient should be rehydrated prior to the CT study if possible or at least on IV fluids to correct the problem if unavoidable.
- Adverse side effects are rare with non-ionic contrast media in correctly hydrated patients.

CT Protocols

CT protocols will vary per region you are attempting to image, patient positioning, slice thickness, algorithms, and whether or not contrast will be used. Each of these factors is critical, but the most commonly overlooked factor is patient positioning. Ensure the region of the patient you are imaging is straight and symmetrically positioned on midline of the CT table, as subtle changes in obliquity may make structures appear abnormal when they are not. Use positional aids, sponges, or troughs if needed, and ensure that all metallic or other unnecessary objects are removed. Place the patient either head-first or hindlimb-first into the gantry, depending on which will be closest to the region for imaging. The following are recommended protocols for different body regions based on common problems seen in MWDs.

CT Skull

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the 2nd to 3rd cervical vertebra. Bone, standard, and bone algorithms with slice thicknesses of 2.5 mm, 1.25 mm, and 0.625 (if available) should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

CT Nasal

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the tip of the nose to the larynx. A bone algorithm with slice thicknesses of 2.5 mm and 0.625 mm (or equivalent) and a standard algorithm with slice thickness of 1.25 mm should be performed. Intravenous contrast should be administered, and the standard algorithm with 1.25 mm thick slices repeated. Dorsal reconstructions are required. Sagittal reconstructions should be made as needed.

CT Brain

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies

should extend from mid-muzzle to the 2nd to 3rd cervical vertebra. Bone, standard, and brain algorithms with slice thicknesses of 2.5 mm, 1.25 mm, and 1.25 mm should be performed, respectively. IV contrast should be administered and brain and standard algorithms repeated. Sagittal and dorsal reconstructions of the standard algorithms are required.

CT Tympanic Bullae

Patient positioning should be in ventral recumbency, with the hard palate parallel to the CT table. Studies should extend from the orbits to the 2nd or 3rd cervical vertebra. Bone and standard algorithms with slice thicknesses of 0.625 - 1.25 mm and 1.25 mm should be performed, respectively. Sagittal and dorsal reconstructions should be made as needed.

CT Spine

Patient should be positioned in dorsal recumbency, with the hind limbs maximally extended caudally (like for a hip-extended VD pelvic view in radiography). Study should extend through necessary vertebral regions based on pain and/or neurolocalization. More specifically for the hind limbs, if UMN signs are present, extend from T8-T9 through sacrum, and if LMN signs present, from T12-T13 through sacrum. CT slices should be acquired perpendicular to vertebral canal (may require gantry rotation). A bone algorithm with 2.5 mm and 1.25 mm slice thicknesses and a standard algorithm with 1.25 mm slice thickness should be performed. For suspect lumbosacral disease, the bone algorithm of 1.25 mm slice thickness should be replaced with 0.625 mm (or equivalent) slice thickness to better visualize the neuroforamina at the lumbosacral junction. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

CT Thorax

Anesthesia and breath holds are required. Patient should be positioned in ventral recumbency. Study should extend from thoracic inlet through caudal aspect of liver (ensure extent of all lungs imaged). Bone, standard, and lung algorithms should be performed with slice thicknesses at 5.0 mm, 2.5 mm, and 1.25-2.5 mm, respectively. Sagittal and dorsal reconstructions of lung and standard algorithms are required.

CT Abdomen

Anesthesia and breath holds are required. Patient should be positioned in dorsal recumbency. Study should extend from caudal margin of cardiac silhouette through pelvic canal (or prostate if male). Bone and standard algorithms should be performed with slice thicknesses at 5.0 mm and 2.5 mm, respectively. Sagittal and dorsal reconstructions of bone and standard algorithms are required.

CT of Extremity or Joint

Patient positioning depends on whether imaging forelimbs or hindlimbs. For forelimbs, the patient is in ventral recumbency. The forelimbs should be extended cranially, resting the forearms and paws on the table with the elbows and shoulders bent at a normal resting position. If the hindlimbs are the focus of the study, the patient is usually placed in dorsal recumbency. The hindlimbs should be placed in maximal caudal extension, keeping both limbs symmetric and including both in the study for comparison purposes (use tape, sponges, or other

positional aids). CT slices should be acquired perpendicular to joint spaces, which may require gantry rotation if the joint is the focus of the study. Bone and standard algorithms should be performed along the affected region with slice thicknesses of 1.25 mm. If a joint the focus of the study, conducting an additional bone algorithm sequence with a slice thickness of 0.625 mm is required (if available). Sagittal and dorsal reconstructions of the affected limb only are required.

Magnetic Resonance Imaging[5]

Magnetic resonance imaging protocols used in veterinary medicine are more simplified compared to human medicine. However, current protocols are adequate in assessing for the majority of diseases of concern.

Anesthesia

Use either an MRI-safe anesthetic machine or constant rate IV anesthesia protocols (See Chapter 16). Patient monitoring presents challenges in the MR gantry due to increased noise, greater chance of hypothermia, and overall decreased patient accessibility.

MRI Technician Assistance

It is very important for the Veterinary Corps Officer to be present during image acquisition (if available) to help determine the beginning and end points (range) of the study in each plane, due to anatomic differences between humans and dogs (humans have five lumbar vertebrae compared to seven in dogs, for instance). Beginning and end points for the study should be based on neurolocalization.

MRI Contrast Administration

Paramagnetic contrast agents are commonly used during MRI. Contrast agent administration is always required when imaging the brain, and may be necessary for other exams dependent on the case. For example, if neoplasia or diskospondylitis of the spine is suspected, then administration of contrast during a spinal exam is warranted. All pre-contrast sequences must be performed prior to contrast bolus administration. The contrast agent most often used in MWDs for MRI is gadolinium-based, and the dose for IV bolus use in the dog is 0.1 mmol/kg (0.2mL/kg). As a quick rule of thumb, 1 mL per 10 pounds body weight is the appropriate dose.

MRI Protocols

MRI Brain

The patient should be positioned in ventral recumbency with the head encased within an effective coil (often head or cardiac types). Studies should extend from the most cranial limit of the orbits/eyes to the level of the 2nd or 3rd cervical vertebra. Slice thicknesses of 3-5 mm should be used; dependent on how many sequences you have time to perform. The following sequences in each respective plane should be performed:

- Axial/Transverse Plane. T1-weighted, T2-weighted, FLAIR, T1-weighted with contrast.
- Sagittal Plane. T1-weighted, T2-weighted, T1-weighted with contrast.
- Coronal/Dorsoventral Plane. T2-weighted, T1-weighted with contrast (T1-weighted pre-contrast also if time allows).

MRI Spine

The patient should be positioned in dorsal recumbency, and the coil within the table will likely be used. Study should extend through necessary vertebral regions based on pain and/or neurolocalization. More specifically for the hindlimbs, if UMN signs are present extend from the 8th or 9th thoracic vertebra through the sacrum, and if LMN signs are present, from the 12th or 13th thoracic vertebra through sacrum. Slice thicknesses of 2-4 mm should be used; dependent on how many sequences you have time to perform. The following sequences within each respective plane should be performed:

- Axial/Transverse Plane. T1-weighted, T2-weighted (T1-weighted with contrast if indicated).
- Sagittal Plane. T1-weighted, T2-weighted, STIR (T1-weighted with contrast if indicated).
- Coronal/Dorsoventral Plane. T2-weighted (T1-weighted pre and post- contrast administration if indicated).

MRI Stifle/Joint Imaging

The patient should be placed in lateral recumbency, with the affected limb up, with the stifle placed in neutral to moderate extension. Study should at least extend from distal femoral diaphysis to the proximal tibial diaphysis, distal to the tibial crest. A wrist coil is preferable, however if the joint/region to be imaged is too large, then cardiac or other similar coils may be used. Slice thicknesses of 2-3 mm should be used; dependent on how much time you have to complete the study. The following sequences within each respective plane should be performed:

- Axial/Transverse Plane. Proton Density (PD)-weighted (+/- fat sat).
- Sagittal Plane. PD-weighted (+/- fat sat), T1-weighted, T2-weighted (+/- fat sat).
- Coronal/Dorsoventral Plane. PD-weighted (+/- fat sat), T2-weighted (+/- fat sat).

Diagnostic Imaging References

1. American Association of Veterinary Radiologists. MRI protocols for dogs. www.aavr.org
2. Department of Defense Veterinary Service Activity. Handbook of Veterinary Care and Management of the Military Working Dog, 2017. In press.
3. Drees R, Dennison SE, Keuler NS, Schwarz T. Computed tomographic imaging protocol for the canine cervical and lumbar spine. Veterinary Radiology & Ultrasound, 2009;50:74-79.
4. Schwarz T and Saunders J (eds). Veterinary Computed Tomography. Danvers, MA: Wiley-Blackwell, 2011.
5. Gavin PR and Bagley R (eds). Practical Small Animal MRI. Danvers, MA: Wiley-Blackwell, 2009.

CHAPTER 21

Euthanasia

MWDs may present with illnesses or injuries so severe that the only humane option is euthanasia. MWDs may be euthanized in the case of catastrophic wounding with poor prognosis for recovery and in order to relieve the MWD from undue suffering. Examples include catastrophic TBI, traumatic limb amputations, decompensatory refractory shock, and major abdominal evisceration injury, in addition to failure to respond to resuscitation, or rapid clinical deterioration with poor prognosis for recovery.

HCPs must recognize the need for euthanasia and perform euthanasia in a humane manner. Normally euthanasia requests must be authorized by either the first field grade officer in the MWD unit supervisory chain of command or a veterinarian. If possible, contact a veterinarian and receive verbal agreement to perform euthanasia. When in doubt, consider the best interest of the MWD, and perform euthanasia if felt necessary to relieve suffering.

All euthanasia procedures will be performed humanely and in accordance with the American Veterinary Medical Association Guidelines on Euthanasia.[1] Note that neuromuscular blocking agents are NOT an acceptable euthanasia agent, even when combined with other drugs.

In the deployed HCP setting, the following 3 options are recommended for canine euthanasia:

1. Commercial veterinary euthanasia solution. Several veterinary euthanasia products are available and include a barbituric acid derivative (usually sodium pentobarbital at ~400 mg/mL), often with local anesthetic agents or agents that metabolize to pentobarbital. Ideally, veterinary personnel will coordinate with adjacent or supporting HCP units to arrange access to these drugs in emergencies. Controlled substances management regulations apply.
    - These products should be given by the IV route.
    - The standard dose of these products is 1 mL per 10 pounds of body weight.
2. Barbiturate overdose. All barbituric acid derivatives used for anesthesia are acceptable for euthanasia when administered intravenously. There is a rapid onset of action, and loss of consciousness induced by barbiturates results in minimal or transient pain associated with venipuncture. Desirable barbiturates are those that are potent, long-acting, stable in solution, and inexpensive.
    - Sodium pentobarbital best fits these criteria and is most widely used.
    - The lethal pentobarbital dose for dogs is 40-60 mg/kg IV.

3. Potassium chloride (KCl). The use of a supersaturated solution of potassium chloride injected is an acceptable method to produce cardiac arrest and death. When using KCl, the MWD MUST BE anesthetized deeply before administration of KCl. It is unethical and unacceptable to use KCl in un-anesthetized animals.
    - Anesthetize the MWD (See Chapter 16).
    - Once anesthetized, rapid IV or IC administration of 1-2 mEq/kg KCl will cause cardiac arrest.
    - A typical dose for an average-sized MWD would be 30-40 mL of 2 mEq/mL KCl.
    - Bolus administration through IV catheter is the preferred route.

It is critical to ensure the death of the MWD after agents have been given for euthanasia. Ensure absence of a heart beat and pulse, absence of voluntary respirations, and absence of electrical activity on an ECG tracing (if available) for at least 5 minutes after presumed death. Agonal respiratory efforts are common and should cease before death is declared.

Whenever possible, a gross necropsy is recommended.

Collect blood and urine samples (one red top and one EDTA tube of blood and urine in a specimen cup or capped syringe) before euthanasia.

The MWD's body (ideally refrigerated, not frozen), all health records, and samples must be sent to the supporting veterinary facility for complete necropsy and final disposition paperwork.

If necropsy by veterinary personnel will be delayed, it is ideal to collect gross samples of major organs and tissues that are obviously abnormal or traumatized, and preserve with 10% buffered formalin. TB MED 283 (Veterinary Necropsy Protocol for Military Working Dogs) is an excellent reference.[2]

If possible and deemed appropriate by the senior HCP present, MWD handlers should be permitted to be present for euthanasia. The bond between handler and MWD cannot be overemphasized, and many handlers will want to be present. Note that the MWD handler as well as providers may require behavioral health care or grief counseling.

Euthanasia References

1. American Veterinary Medical Association. AVMA guidelines for the euthanasia of animals: 2013 edition. Available at: www.avma.org/KB/documents/guidleines_for_the_euthanasia_of_animals_2013.aspx. Accessed 01 November 2016.
2. TB MED 283. Veterinary Necropsy Protocol for Military Working Dogs and Pathology Specimen Submission Guidelines. Headquarters, Department of the Army, 24 May 2001.

CHAPTER 22

Documentation—Medical Records

Canine Tactical Combat Casualty Care (cTCCC) Card

To document care at the point of injury, a canine Tactical Combat Casualty Care card (cTCCC card) has been approved for use, and is included in this chapter. This form should be used to document trauma or Disease, Non-Battle Injury at the point of injury anywhere an MWD is deployed, by the handler or provider who first provides care. Once care has been transferred to a medical facility, the form should be submitted to veterinary personnel for submission, or scanned and emailed by HCPs to dog.consult@us.af.mil.

The fillable electronic cTCCC care and instructions are available at:

https://jts.amedd.army.mil/assets/docs/forms/Canine_Tactical_Combat_Casualty_Card.pdf

https://jts.amedd.army.mil/assets/docs/forms/Instructions_Canine_Trauma_Combat_Casualty_Card.pdf

Canine Resuscitation Record Worksheet

To document medical care of MWDs by HCPs, all medical care provided in military medical facilities should be documented on the Canine Resuscitation Record. This new worksheet is included in this chapter. Input all relevant information to the best of your ability, recognizing the form has been revised for canine-specific information, and thus is significantly different from the DD Form 3019 used for human patients. Use a new worksheet each day the dog is an inpatient in the facility. Maintain the worksheets throughout the patient's care. Once care has been transferred to supporting veterinary personnel, either provide the worksheet to them, or scan and email it to dog.consult@us.af.mil.

The fillable electronic worksheet and instructions are available at:

https://jts.amedd.army.mil/assets/docs/forms/Canine_Resuscitation_Record.pdf

https://jts.amedd.army.mil/assets/docs/forms/Canine_Resuscitation_Record_Instructions.pdf

Figure 49. Canine Tactical Combat Casualty Care Card (CTCCC), Page 1 of 2

CANINE-TACTICAL COMBAT CASUALTY CARE CARD (cTCCC)

EVAC CAT: ☐Urgent ☐Priority ☐Routine ☐MEDEVAC ☐CASEVAC

EVAC TYPE: ☐Fixed ☐Rotary ☐Ground

UNIT: _____ **NAME:** _____ **TATTOO:** _____ **BREED:** _____

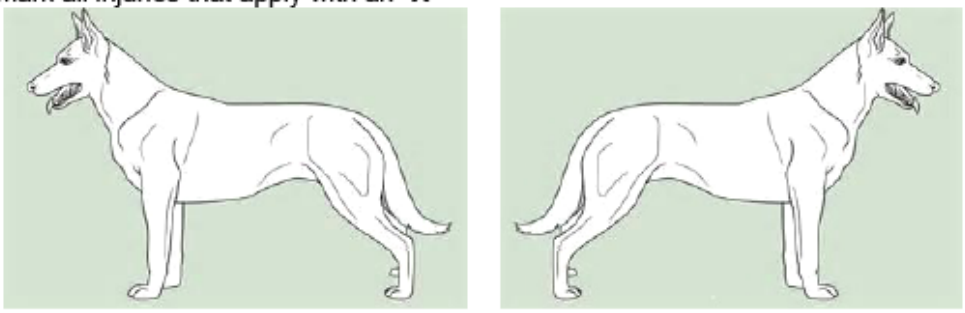
DATE (DD-MM-YY): _____ **TIME:** _____

GENDER: ☐M ☐F **CASTRATION/SPAY:** ☐Y ☐N

BLOOD: DEA 1.1
☐POS ☐NEG

Mechanism of Injury: (X all that apply)
☐IED ☐GSW ☐MINE ☐BURN ☐GRENADE ☐ARTILLERY ☐MORTAR ☐FALL
☐OTHER: _____

Injury: (Mark all injuries that apply with an **X**



VITAL SIGNS

Time					
Acute Pain Score (≤1)					
Temperature (99-102)					
Pulse Rate (60-80)					
Respiratory Rate (16-30)					
Blood Pressure (120/80)					
Pulse Ox% > 95%					
Capillary Refill (< 2 sec)					

CANINE ACUTE PAIN SCALE

SCORE	BEHAVIORAL	PALPATION	BODY TENSION
0	Comfortable when resting	Nontender to wound palpation	Minimal
1	Slightly unsettled or restless	Reacts to palpation of wound	Mild
2	Uncomfortable at rest, whimpers, lick s wound	Flinches, whimpers, cries	Mild to Moderate (reassess analgesic plan)
3	Unsettled, crying, groaning, biting, chewing wound	Increased respiratory rate, sharp cry, growl, bite	Moderate (reassess analgesic plan)
4	Constantly groaning or screaming when unattended, may bite wound	Cries at non - painful palpation, may react aggressively	Moderate to severe (reassess analgesic plan)

FIRST RESPONDERS:

RANK	LAST, FIRST	DUTY AOC/MOS	DATE

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CANINE-TACTICAL COMBAT CASUALTY CARE CARD (cTCCC)

Treatments: (X all that apply)

C: ☐ Extremity-TQ ☐ Junctional-TQ ☐ Pressure-Dressing ☐ Hemostatic-Dressing

Type/Other: _____

A: ☐ Intact ☐ ET-Tube with bite guard ☐ Tracheostomy ☐ Tracheal Insufflation (Muzzle: ☐ Y ☐ N)

B: ☐ O^2 ☐ Needle-D ☐ Chest-Tub ☐ Chest-Seal Type: _____

(75% of K9s have fenestrated mediastinums)

FLUIDS: **(Trauma MAP target 65mmHg; Hemorrhage MAP 40mmHg; TBI MAP 80mmHg)**

Total Crystalloid Shock Volume of fluids is 90 mls/kg: Give ¼ of the Total Shock Fluid Volume IV/IO in 10 - 20 min. then reassess; repeat another ¼ of the calculated "shock" volume if necessary every 10 min. until targeted endpoints			
CRYSTALLOID	**VOLUME**	**ROUTE**	**TIME**
HYDROXYETHYL STARCH (HES) 10 - 20mls/kg over 5 - 10 min. (after ½ shock crystalloid not effective)			
HYPERTONIC SALINE 4mls/kg (If two or three ¼ shock boluses and one or two boluses of HES not effective)			
MWD Blood /Plasma (no human) 2.5 - 10mls/kg			

(First blood transfusion can be done without blood typing)

MEDS:

	NAME	DOSE	ROUTE	TIME
ANALGESIC				
ANTIBIOTIC				
TXA 10 mg/kg in 100ml NaCl or LRS followed by 10 mg/kg/h CRI over 3 hours)				

OTHER: ☐ Gastric Trocarization ☐ External Cooling (tap water) ☐ Splint ☐ Hypothermia-Prevention ☐ Muzzle ☐ Other:

DRUG (conc.)	DOSE	RTE	60lb/ 27.3kg	70lb/32kg	80lb/36.4kg
Ketamine (100mg/ml)	2-5mg/kg	IV/IM	1 ml	1.5 mls	2 mls
Midazolam (2mg/ml)	0.1-0.3mg/kg	IV/IM	3 mls	4 mls	5 mls
Hydromorphone (2mg/ml)	0.1-0.2mg/kg	IV/IM	1.5 mls	1.75 mls	2 mls
Ketorolac (30mg/ml)	0.5mg/kg	IV/IM /PO	0.5 mls	0.55 mls	0.6 mls
Ertapenem (100mg/ml)	15mg/kg	IV/SQ	4 mls	5 mls	6 mls
Morphine (10mg auto inj.)	0.2-0.5 mg/kg	IM	1 *auto*	1 *auto*	2 *auto*
Diphenhydramine	1-2 mg/kg	IV/IM/PO	50 *mg*	75 *mg*	100 *mg*
Meloxicam	0.1-0.2mg/kg	IV/SQ/PO	5 *mg*	6 *mg*	7 *mg*
Amoxicillin Clavulanic Acid	- 13.75mg/kg	PO	375 *mg*	440 *mg*	500 *mg*
Cefazolin	20-30mg/kg	IV/IM	600 *mg*	650 *mg*	700 *mg*
Cefotaxime	22 mg/kg	IV/IM/SQ	600 *mg*	700 *mg*	800 *mg*
Ceftriaxone	25 mg/kg	IV/IM	700 *mg*	800 *mg*	900 *mg*

NOTES: _____

_____

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General Instructions for Canine Trauma Combat Casualty Care Card

PURPOSE: The Canine Tactical Combat Casualty Care (cTCCC) card is for documenting a trauma or disease non-battle injury (DNBI) at the point of injury anywhere a canine is deployed in support of DoD operations. The cTCCC card will be filled out by the handler or provider who attends to the canine's trauma or DNBI. After medical treatment and resuscitation care is provided, the cTCCC card can be handed off to the nearest veterinary treatment facility or supporting veterinary unit to be scanned, uploaded and emailed to dog.consult@us.af.mil or the unit providing care can email directly. Once the MWD Trauma Registry is online, the first veterinary unit will input the information into the registry and scan the cTCCC card to upload into ROVR. The cTCCC card becomes part of the canine's permanent DoD medical record. For US Special Operations Command (SOCOM) canines, the cTCCC card will be filled out and returned to the handler or operator. The handler or operator will route the card to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.

PAGE 1:

GENERAL INSTRUCTIONS

- To be completed by the handler, human medical provider, veterinary technician or veterinarian fulfilling the role at the point of injury.
- Time Zones: Record all time local 24 hour military format, hh:mm
- A+ (plus sign) means positive test result; a - (minus sign) means negative test result.

EVACUATION CATEGORY (mark as appropriate)

URGENT – Patient who should be evacuated as soon as possible and within **two** hours to save life, limb or eyesight

PRIORITY – Patient who should be moved within **four** hours or their condition will deteriorate to such a degree that will be urgent

ROUTINE – Patient whose condition is not expected to worsen significantly and who will require evacuation in the next **24** hours

EVACUATION MODE & TYPE (mark as appropriate)

PATIENT IDENTIFICATION

UNIT. Record the unit the canine is assigned

ANIMAL NAME. (self-explanatory)

TATTOO. (self-explanatory)

BREED. (self-explanatory)

DATE. (DD-MM-YY)

TIME. Record all time local 24 hour military format, hh:mm

BLOOD. DEA 1.1 (mark as appropriate if known)

GENDER. (mark as appropriate)

MECHANISM OF INJURY (mark as appropriate – use other for DNBI or if unknown – describe)

INJURY (mark the diagram where the trauma/injury or disease is located – if there are more than one injury, identify each with the mechanism of injury)

General Instructions for Canine Trauma Combat Casualty Care Card

VITAL SIGNS (input vital signs at least hourly)

FIRST RESPONDERS (self-explanatory)

PAGE 2:

TREATMENTS (mark as appropriate)

C (circulation): self-explanatory

A (airway): self-explanatory

B (breathing): self-explanatory

FLUIDS (fill out as appropriate and complete as possible)

MEDICATIONS (MEDS) (fill out as appropriate and complete as possible – if other medications are given that aren't mentioned on the form, please include whether they are an analgesic, antibiotic or TXA. Be as thorough as possible)

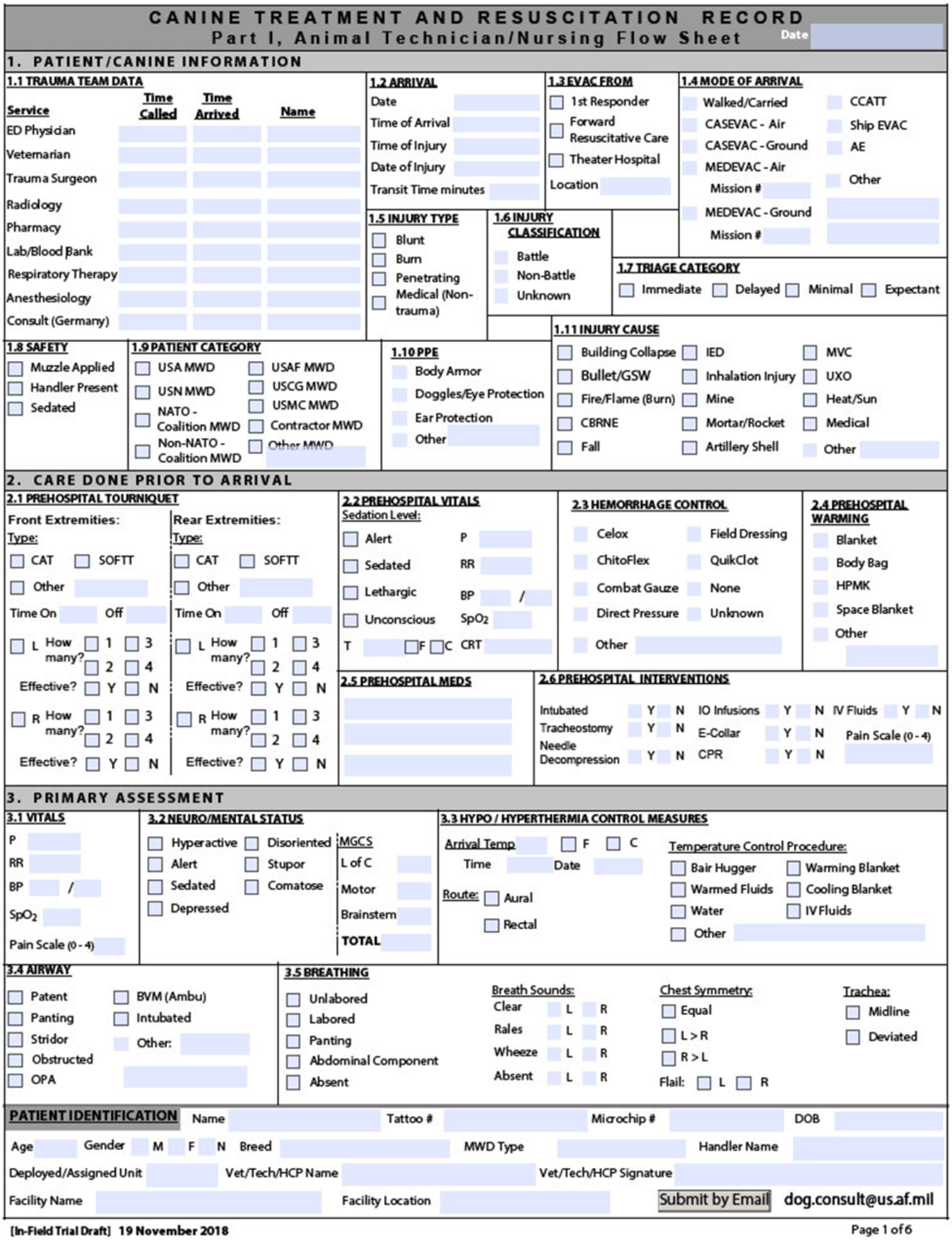
OTHER (Include other lifesaving techniques or treatments)

NOTES (Include any additional information (location/country, euthanized/KIA, treatment regiments that were used to the treat the patient, etc.)

DISPOSITION OF THE FORM – (The form is to be kept with the patient until it can be put into the patient's record.) Pass the card to the next treatment facility. 1) Scan and email the card to dog.consult@us.af.mil . 2) Put the card into the patient's hard copy record. CAVEAT: For US Special Operations Command (SOCOM) canines, the cTCCC card will be filled out and returned to the handler or operator. The handler or operator will route the card to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.

DEFINITIONS
IED – Improvised explosive device
GSW – Gunshot wound
TQ – Tourniquet
ET – Endotracheal tube
TXA – Tranexamic acid

Figure 50. Canine Treatment and Resuscitation Record Worksheet, Page 1 of 6



CANINE TREATMENT AND RESUSCITATION RECORD
Part I, Animal Technician/Nursing Flow Sheet Date

1. PATIENT/CANINE INFORMATION

1.1 TRAUMA TEAM DATA

Service	Time Called	Time Arrived	Name
ED Physician			
Veterinarian			
Trauma Surgeon			
Radiology			
Pharmacy			
Lab/Blood Bank			
Respiratory Therapy			
Anesthesiology			
Consult (Germany)			

1.2 ARRIVAL
Date
Time of Arrival
Time of Injury
Date of Injury
Transit Time minutes

1.3 EVAC FROM
☐ 1st Responder
☐ Forward Resuscitative Care
☐ Theater Hospital
Location

1.4 MODE OF ARRIVAL
Walked/Carried
CASEVAC - Air
CASEVAC - Ground
MEDEVAC - Air
Mission #
MEDEVAC - Ground
Mission #
CCATT
Ship EVAC
AE
Other

1.5 INJURY TYPE
☐ Blunt
☐ Burn
☐ Penetrating
☐ Medical (Non-trauma)

1.6 INJURY CLASSIFICATION
Battle
Non-Battle
Unknown

1.7 TRIAGE CATEGORY
☐ Immediate ☐ Delayed ☐ Minimal ☐ Expectant

1.8 SAFETY
☐ Muzzle Applied
☐ Handler Present
☐ Sedated

1.9 PATIENT CATEGORY
☐ USA MWD ☐ USAF MWD
☐ USN MWD ☐ USCG MWD
☐ NATO - Coalition MWD ☐ USMC MWD
☐ Non-NATO - Coalition MWD ☐ Contractor MWD
☐ Other MWD

1.10 PPE
Body Armor
Doggles/Eye Protection
Ear Protection
Other

1.11 INJURY CAUSE
☐ Building Collapse ☐ IED ☐ MVC
☐ Bullet/GSW ☐ Inhalation Injury ☐ UXO
☐ Fire/Flame (Burn) ☐ Mine ☐ Heat/Sun
☐ CBRNE ☐ Mortar/Rocket ☐ Medical
☐ Fall ☐ Artillery Shell Other

2. CARE DONE PRIOR TO ARRIVAL

2.1 PREHOSPITAL TOURNIQUET

Front Extremities:
Type:
☐ CAT ☐ SOFTT
☐ Other
Time On Off
☐ L How many? ☐ 1 ☐ 2 ☐ 3 ☐ 4
Effective? ☐ Y ☐ N
☐ R How many? ☐ 1 ☐ 2 ☐ 3 ☐ 4
Effective? ☐ Y ☐ N

Rear Extremities:
Type:
☐ CAT ☐ SOFTT
☐ Other
Time On Off
☐ L How many? ☐ 1 ☐ 2 ☐ 3 ☐ 4
Effective? ☐ Y ☐ N
☐ R How many? ☐ 1 ☐ 2 ☐ 3 ☐ 4
Effective? ☐ Y ☐ N

2.2 PREHOSPITAL VITALS
Sedation Level:
☐ Alert
☐ Sedated
☐ Lethargic
☐ Unconscious
T ☐F ☐C
P
RR
BP /
SpO_2
CRT

2.3 HEMORRHAGE CONTROL
Celox
ChitoFlex
Combat Gauze
Direct Pressure
Other
Field Dressing
QuikClot
None
Unknown

2.4 PREHOSPITAL WARMING
Blanket
Body Bag
HPMK
Space Blanket
Other

2.5 PREHOSPITAL MEDS

2.6 PREHOSPITAL INTERVENTIONS
Intubated Y N
Tracheostomy Y N
Needle Decompression Y N
IO Infusions Y N
E-Collar Y N
CPR Y N
IV Fluids Y N
Pain Scale (0 - 4)

3. PRIMARY ASSESSMENT

3.1 VITALS
P
RR
BP /
SpO_2
Pain Scale (0 - 4)

3.2 NEURO/MENTAL STATUS
☐ Hyperactive ☐ Disoriented
☐ Alert ☐ Stupor
☐ Sedated ☐ Comatose
☐ Depressed
MGCS
L of C
Motor
Brainstem
TOTAL

3.3 HYPO / HYPERTHERMIA CONTROL MEASURES
Arrival Temp ☐ F ☐ C
Time Date
Route: ☐ Aural ☐ Rectal
Temperature Control Procedure:
☐ Bair Hugger ☐ Warming Blanket
☐ Warmed Fluids ☐ Cooling Blanket
☐ Water ☐ IV Fluids
☐ Other

3.4 AIRWAY
☐ Patent ☐ BVM (Ambu)
☐ Panting ☐ Intubated
☐ Stridor Other:
☐ Obstructed
☐ OPA

3.5 BREATHING
☐ Unlabored
☐ Labored
☐ Panting
☐ Abdominal Component
☐ Absent
Breath Sounds:
Clear L R
Rales L R
Wheeze L R
Absent L R
Chest Symmetry:
☐ Equal
☐ L > R
☐ R > L
Flail: ☐ L ☐ R
Trachea:
☐ Midline
☐ Deviated

PATIENT IDENTIFICATION Name Tattoo # Microchip # DOB
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TOC

CANINE TREATMENT AND RESUSCITATION RECORD
Part I, Animal Technician/Nursing Flow Sheet

Date

3. PRIMARY ASSESSMENT (CONT.)

3.6 NOTES

3.7 CIRCULATION

Mucus Membrane: ☐ Hot ☐ Warm ☐ Cool; ☐ Pink ☐ Pale; ☐ Moist ☐ Dry; ☐ Cyanotic ☐ Brick Red

Heart Sounds: ☐ Clear ☐ Muffled

CRT: ☐ < 2 s ☐ ≥ 2 s

4. SECONDARY SURVEY

4.1 HEAD / NECK ENT

Drainage:
☐ Nasal (Color)
☐ Ear (Color)

Dental Injury ☐ Y ☐ N

JVD ☐ Y ☐ N

Reactive Pupils

Right:	Left:
☐ Y ☐ N	☐ Y ☐ N
Brisk	Brisk
Sluggish	Sluggish
NR	NR

4.2 HEART

Rhythm
☐ NSR ☐ PEA
☐ Tachy ☐ Brady
☐ V-fib ☐ V-tach
☐ Asystole
☐ Normal Sinus Arrhythmia
☐ Other

Pulses
S = Strong W = Weak
D = Doppler A = Absent

Femoral L R

Dorsal Metatarsal L R

4.3 ABDOMINAL

☐ Open Wound
☐ Flat
☐ Distended
☐ Rigid
☐ Bruising
☐ Soft
☐ Pain

FAST + / -

Site ☐ DH ☐ CC ☐ SR ☐ HR

4.4 EXTREMITIES

Deformities	Pulses Present	Motor	Sensory
LF		☐ Y ☐ N	☐ Y ☐ N
RF		☐ Y ☐ N	☐ Y ☐ N
LR		☐ Y ☐ N	☐ Y ☐ N
RR		☐ Y ☐ N	☐ Y ☐ N

Pulses Present: indicate S=Strong W=Weak D=Doppler A=Absent

4.5 ALLERGIES

☐ Unknown
☐ NKDA
Other

4.6 CURRENT MEDICATIONS

☐ Unknown ☐ None
☐ Current Meds: (List med, dose, & route)

4.7 MEDICAL HISTORY

4.8 PROCEDURES

Procedure	Time	Size/Type	Site	Performed By	Results/Notes
O_2 Therapy Lpm %	On / Off	☐ Low Flow Blow By ☐ High Flow Blow By	☐ OPA ☐ Nasal Cannula ☐ BVM/(Ambu)		
ET Intubation	Time	Trach Tube mm	Oral / Tracheostomy		$ETCO_2$ Change / BBS Post Intubation
Chest Tube #1	Time		☐ L ☐ R		☐ Air Blood (ml)
Chest Tube #2	Time		☐ L ☐ R		☐ Air Blood (ml)
Needle Decompression	Time		☐ L ☐ R		☐ Air Blood (ml)
Tourniquet	Time	Types	LF RF LR RR		
Urinary	Time	Amount Color Foley Size			
Other Procedure	Time	Describe			
Other Procedure	Time	Describe			
Other Procedure	Time	Describe			

Hemorrhage Control: Celox, Combat Gauze, Field Dressing, QuikClot, ChitoFlex, Direct Pressure, HemCon, None, Unknown, Other

PATIENT IDENTIFICATION

Name Tattoo # Microchip # DOB

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CANINE TREATMENT AND RESUSCITATION RECORD
Part I, Animal Technician/Nursing Flow Sheet

Date

4. SECONDARY SURVEY, continued

4.9 VENT SETTINGS

Time
Mode:
FiO2:
Rate:
PEEP:
TV:
Notes:

4.10 INTRAVENOUS/INTRAOSSEOUS ACCESS AND FLUIDS/BLOOD PRODUCTS

Start Time	Rate	Type	Gauge	Site	IVF Type	Amount Up	Amount In	Stop Time	Initials
		☐ IV ☐ IO							
		☐ IV ☐ IO							
		☐ IV ☐ IO							
		☐ IV ☐ IO							
		☐ IV ☐ IO							

4.11 MEDICATIONS

Start Time	Drug	Dose	Site	Route	Stop Time	Initials

4.12 LABS

Time	Test	Time	Test
	CBC		INR
	Chem7		Lactate
	Chem12		U/A
	H&H		☐ Other, specify:
	ABG/Serial		
	VBG		
	PT/PTT		

4.13 CT

Type	Time
☐ Head	
☐ Spine	
☐ Chest	
☐ Abd/Pelvis	
☐ Pan Scan	

4.14 X-RAY

Type	Time
☐ Head	
☐ Spine	
☐ Chest	
☐ Abd	
☐ Pelvis	

☐ Extremity
☐ LF
☐ RF
☐ LR
☐ RR
Time

4.15 Pending Studies

4.16 Results

4.17 VITAL SIGNS

Time	BP	P	RR	Temp	SpO2	Other (ICP)	Initials

4.18 DISPOSITION

Date: Time: Handler Present: ☐ Y ☐ N

RTD ☐ Full ☐ Light Work ☐ No Work for Days

Admit ☐ OR ☐ ICU ☐ ICW ☐ Vet Clinic

Evac to ☐ VTF Role 2 ☐ VTF Role 3 ☐ VMCE Facility Name:

Evac Priority ☐ Routine ☐ Priority ☐ Urgent

Evac Mode ☐ Ambulatory ☐ Gurney/Litter ☐ Crate/Kennel

Evac Transport Vehicle
MEDEVAC: ☐ Rotary Wing ☐ Fixed Wing ☐ CCATT
Ground: ☐ Ambulance ☐ Non-Medical

4.19 NOTES

PATIENT IDENTIFICATION Name Tattoo # Microchip # DOB

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CANINE TREATMENT AND RESUSCITATION RECORD

Part II, Veterinarian/Physician

Date

1. HISTORY & PHYSICAL - INJURY DESCRIPTION

1.1 ARRIVAL

Date

Time of Arrival

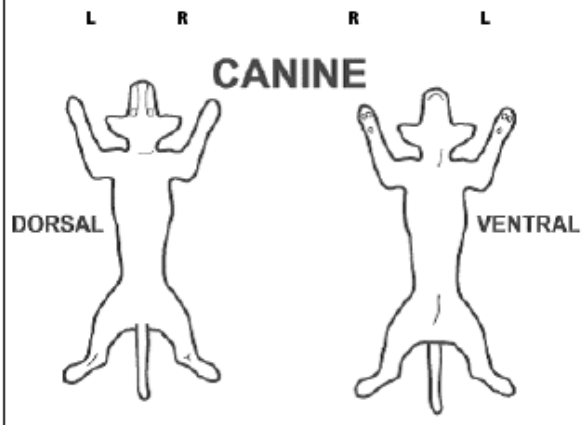
1.2 TRIAGE CATEGORY

- ☐ Immediate
- ☐ Delayed
- ☐ Minimal
- ☐ Expectant

1.3 CHIEF COMPLAINT, HISTORY AND PRESENTING ILLNESS

1.4 INJURY DESCRIPTION

(AB)rasion
(AMP)utation
(AV)ulsion
(BL)eeding
(B)urn %TBSA_____
(C)repitus
(D)eformity
(DG)Degloving
(E)cchymosis
(FX)Fracture
(F)oreign Body
(GSW)Gun Shot Wound
(H)ematoma
(I)llness (not trauma)
(LAC)eration
(PW)Puncture Wound
(SW)Stab Wound
(P)ain
(PP)Peppering



Pulses Present
S= Strong **W**= Weak **D**= Doppler **A**=Absent

1.5 HISTORY AND PHYSICAL

Head & Neck :

Chest:

Abdomen/Back and Spine:

Pelvis: ☐ Stable ☐ Unstable

Front Extremities:

Rear Extremities:

Interventions Prior to Arrival:

1.6 PRE / INITIAL PROCEDURES / DIAGNOSTICS

Pre / Initial

- ☐ ☐ Trach
- ☐ ☐ ICP Monitor
- ☐ ☐ Eye Injury ☐ L ☐ R
- ☐ Fluorescein - / +

Pre / Initial

- ☐ ☐ Cantholysis & Canthotomy ☐ L ☐ R
- ☐ ☐ Tympanic Membranes Rupture ☐ L ☐ R
- Blood ☐ L ☐ R

Needle Decompression ☐ R ☐ L Pericardial FAST - / +

Output ☐ Air Describe

☐ Blood (ml) Thoracic FAST - / +

☐ Pericardiocentesis Site ☐ L CTS ☐ R CTS

DPL ☐ Gross Blood: - / + Describe

Serial AFAST - / + Site ☐ DH ☐ CC ☐ SR ☐ HR

Rectal Exam ☐ WNL ☐ Weak/Absent Tone Gross Blood: - / +

Front Extremities:
☐ Closed Reduction ☐ EXT Fixation ☐ Splint ☐ Wound Washout
☐ Tourniquet ☐ L # ☐ R #

Rear Extremities:
☐ Closed Reduction ☐ EXT Fixation ☐ Splint ☐ Wound Washout
☐ Tourniquet ☐ L # ☐ R #

Interventions Prior to Arrival:
☐ Sedated ☐ Hypertonic Saline ☐ Mannitol ☐ Seizure Protocol
☐ Central Line Loc Site
☐ IO/IV Loc Site

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CANINE TREATMENT AND RESUSCITATION RECORD
Part II, Veterinarian/Physician

Date

1.7 PUPILS / VISION

Brisk L R Sluggish L R NR L R Hand Motion L R
Light Perception L R No Light Perception L R
Aniscoria L > R R > L

1.8 BURN

Super Deep PT %TBSA Cause
Super PT Full

1.9 EXTREMITIES

	Motor	Sensory	ROM
LF	+ / -	+ / -	+ / -
RF	+ / -	+ / -	+ / -
LR	+ / -	+ / -	+ / -
RR	+ / -	+ / -	+ / -

2. LABORATORY RESULTS

2.1 CBC

WBC
RBC
HGB
HCT
PLT

2.2 CHEMISTRY 7/12

Na Gluc TProtein
K BUN ALT
Cl Crea AST
Ca Albumin ALP
CO2 TBili Lactate

2.3 COAG

PT
PTT
INR

2.4 Blood Type

2.5 VBG/ABG

	VBG	ABG
pH		
PaO2		
PaCO2		
HCO3		
SaO2		

2.6 URINALYSIS

SpGr
pH
LEU
PRO
GLU
KET
UBG
BIL
HGB

2.7 OTHER LABS

3. X-RAYS and CT

3.1 CT OBTAINED

Head
Spine
Chest
Abd/Pelvis
Pan Scan*
* Select Pan Scan only if all of the above requested

3.2 X-RAYS OBTAINED

Head Extremity
Spine LF
Chest RF
Abd LR
Pelvis RR
Other
Other
Other

3.3 Foreign Body

Projectile Shrapnel Debris
Incendiary Device Bones
Other:

3.4 PENDING STUDIES

3.5 RESULTS (include TEG/Rotem results)

4. IMPRESSION/ASSESSMENT

4.1 Severity

Critical
Severe
Moderate
Mild

4.2 Impression/Assessment Comments

5. DIAGNOSES

1. 7.
2. 8.
3. 9.
4. 10.
5. 11.
6. 12.

PATIENT IDENTIFICATION Name Tattoo # Microchip # DOB

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CANINE TREATMENT AND RESUSCITATION RECORD
Part II, Veterinarian/Physician

Date

6. PLAN

6.1 PLAN

7. DNBI / NBI CATEGORY

☐ Injury, MVC ☐ Surgical ☐ Other
☐ Injury, Work/Training ☐ Disease ☐ Describe

8. CAUSE OF DEATH

8.1 ANATOMIC

☐ Airway ☐ Neck ☐ Abdomen
☐ Head ☐ Chest ☐ Pelvis
☐ Extremity ☐ LF ☐ RF ☐ LR ☐ RR
☐ Other, Specify

8.2 PHYSIOLOGIC

☐ MOF ☐ Sepsis ☐ CNS ☐ Hemorrhage ☐ Breathing
☐ Heart Failure ☐ Total Body Disruption
☐ Other, Specify

8.3 DEATH INFORMATION

Date of Death Time of Death Mortuary Affairs Notified? ☐ N/A ☐ Y ☐ N
Euthanized ☐ Y ☐ N Method
Gross Necropsy by DVM ☐ Y ☐ N Necropsy Date Necropsy Time
Time between death and necropsy Gross Pathology Report: ☐ Y ☐ N ☐ Unknown
Samples Shipped to JPC ☐ Y ☐ N ☐ N/A ☐ Unknown
Death Remarks

PATIENT IDENTIFICATION Name Tattoo # Microchip # DOB
Age Gender M F N Breed MWD Type Handler Name
Deployed/Assigned Unit Vet/Tech/HCP Name Vet/Tech/HCP Signature
Facility Name Facility Location Submit by Email dog.consult@us.af.mil

General Instructions for Canine Treatment and Resuscitation Record

PURPOSE: The Canine Treatment and Resuscitation Record is for documenting a canine's illness or traumatic injuries and related medical treatment and resuscitation care provided at DOD veterinary medical treatment facility (VTFs) or medical treatment facilities (MTFs). It is to be used at all DoD VTFs & MTFs which have a surgical capability or emergency department (ED). It is also to be used to document all instances of Disease Non-Battle Injury (DNBI) seen at Role II VTFs. In cases of DNBI, complete only the applicable sections. A canine trauma patient is defined as a canine who has an injury or illness with the potential of requiring a surgical intervention. The form is comprised of two parts. Part I, Nursing Flow Sheet is completed by the veterinary technician or nurse fulfilling the role as a scriber or the nurse providing bed side care. Part II, Physician H&P (History and Physical) is completed by the trauma veterinarian or physician providing care for the patient. The Canine Treatment and Resuscitation Record becomes part of the patient's permanent DOD medical record. For US Special Operations Command canines, the Canine Treatment and Resuscitation Record will be filled out and returned to the handler or operator. The handler or operator will route the record(s) to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.

PART I: ANIMAL TECHNICIAN / NURSING FLOW SHEET

GENERAL INSTRUCTIONS

- To be completed by the technician / nurse fulfilling the role as a scriber or the technician / nurse providing care.
- Time Zones: Record all time local 24 hour military format, hh:mm
- A + (plus sign) means positive test result; a - (minus sign) means negative test result.
- Record date on top of each page. The date should be the day when care is initiated. If the dog receives multiple days of care, use a new, correctly dated form each day.

PATIENT IDENTIFICATION (at bottom of each page). As stated.

NAME. Name of the Military Working Dog (MWD)

TATTOO. Tattoo identifier (located on the inner surface of the MWD's left ear)

MICROCHIP #. Nine, 12 or 15 digit number specific to the MWD. Record if known or scan if available.

DOB. Date of Birth as listed on the record or in the Remote Online Veterinary Record (ROVR)

AGE. Dog's age in years

GENDER. Male, Female, Neutered (used for both genders)

BREED. Dog's breed as listed on the record or in ROVR. Recognized abbreviations are acceptable (e.g. German Shepherd Dog – GSD, Dutch Shepherd – DS, Belgian Malinois – B Mal, Labrador Retriever – Lab)

MWD TYPE. MWD's type of service, e.g. PEDD, SSD, MPC, IEDD

HANDLER NAME. Name of the person accompanying MWD

DEPLOYED / ASSIGNED UNIT. MWD's owning unit

VET / TECH / HCP NAME. Name of the person responsible for the care of the MWD.

VET / TECH / HCP SIGNATURE. Signature of the responsible provider completed after reviewing the form for accuracy and completeness.

FACILITY NAME. Record your VTF or MTF unit identifier

FACILITY LOCATION. Record FOB, COB, or geographic site

1.0 PATIENT / CANINE INFORMATION

1.1 TRAUMA TEAM DATA. As stated. Record all time local 24 hour military format, hh:mm

General Instructions for Canine Treatment and Resuscitation Record

1.2 ARRIVAL. As stated.

1.3 EVAC FROM. Check all that apply. Location is the facility name.

1.4 MODE OF ARRIVAL. Check one.

WALKED/CARRIED. As stated.

CASEVAC – Air. Casualty Evacuation via non-medical rotary wing aircraft.

CASEVAC – Ground. Casualty Evacuation via non-medical ground transport vehicle.

MEDEVAC - Air includes DUSTOFF. Medical Evacuation via helicopter. Record mission number when known.

MEDEVAC – Ground. Medical Evacuation via ambulance. Record mission number when known.

CCATT. Critical Care Air Transport Team.

SHIP EVAC. Evacuation via US Navy vessel.

AE. Aeromedical Evacuation. Casualty Evacuation via USAF fixed-wing aircraft.

If Other, describe the method by which the patient arrived, such as USAF Pararescue (PJ or Pedro) or United Kingdom Medical Emergency Response Team (MERT), but not DUSTOFF.

1.5 INJURY TYPE. Check all that apply.

1.6 INJURY CLASSIFICATION. Check one.

1.7 TRIAGE CATEGORY. Check one.

Immediate - Patients who require rapid, immediate intervention in order to preserve life and/or limb AND are likely to survive because of the intervention--damage control surgery (e.g.: respiratory obstruction, unstable casualty with chest or abdominal injuries, uncontrolled hemorrhage, hypovolemic shock, emergency amputation).

Delayed - Patients who require surgery or other specific therapeutic intervention, but who will not be severely compromised if the intervention is delayed to a later time (e.g. closed fracture without neurovascular compromise, moderate burns of < 50% TBSA, large muscle wounds, intra-abdominal and/or thoracic wounds).

Minimal - Non-Urgent: Minor Injuries; MWD can be safely cared for by veterinary staff or be monitored by handler. (e.g. Minor lacerations, abrasions, fractures of digits/distal tail, and minor burns). Can safely wait 12-24 hours or longer for care.

Expectant - Patients whose injuries are so severe that even with the benefit of optimal medical resources, their survival would be unlikely (e.g. massive open head injury with brain matter present, high spinal cord injuries, mutilating explosive wounds involving multiple anatomical sites and organs, second/third degree burns in excess of 60% TBSA, profound shock with multiple injuries and agonal respirations).

1.8 SAFETY. Check all that apply.

1.9 PATIENT CATEGORY. Check one.

USA MWD. United States Army-owned MWD

USAF MWD. United States Air Force-owned MWD

USMC MWD. United States Marine Corps-owned MWD

USN MWD. United States Navy-owned MWD

USCG MWD. United States Coast Guard-owned MWD

Contractor MWD. Specify Contractor Company

General Instructions for Canine Treatment and Resuscitation Record

NATO-Coalition MWD. NATO country military forces-owned MWD. Specify country.

Non-NATO Coalition MWD. Non-NATO military forces-owned MWD. Specify country.

Other. If Other, describe the patient's classification as it relates to military, government or civilian organizations.

1.10 PERSONAL PROTECTIVE EQUIPMENT (PPE). Check all that apply. Collect the PPE and ensure it is transported with the canine.

1.11 INJURY CAUSE. Check all that apply. If Other, describe cause of the injury.

IED. Improvised Explosive Device

MVC. Motor Vehicle Crash

GSW. Gunshot Wound

UXO. Unexploded Ordinance

CBRNE. Chemical, Biological, Radiological, Nuclear and Explosives. Specify

Mortar/Rocket/Artillery Shell. Includes Indirect and Direct Fire

2.0 CARE DONE PRIOR TO ARRIVAL

GENERAL INSTRUCTIONS

- Information for this section should be taken from any medical records that accompany the MWD. This may include a Canine - Tactical Combat Casualty Card (cTCCC), SF 600 notes, ROVR digital medical records (eNOTE), or handler recollection. Complete as thoroughly and with as much detail as possible.
- Time Zones: Record all time local 24 hour military format, hh:mm
- A + (plus sign) means positive test result; a - (minus sign) means negative test result.

2.1 PREHOSPITAL TOURNIQUET. Check all that apply.

CAT. Combat Application Tourniquet.

SOFFT. Combat Application Tourniquet

Other. If other, describe the type of tourniquet.

Effective. An effective tourniquet controls active hemorrhage. May be combined with a dressing.

2.2 PREHOSPITAL VITALS. As stated.

SpO2. Do not attempt to obtain an O2 saturation measurement from the lip or tongue of an unsedated MWD. Use the prepuce, vulva, toe webbing or ear pinna as an alternate location.

2.3 HEMORRHAGE CONTROL. Check all that apply.

Celox. Granules, applicator or gauze. Stops bleeding by bonding with red blood cells and gelling with fluids to produce a sticky pseudo clot. This clot sticks to moist tissue to plug the bleeding site. Celox is made with chitosan, a natural polysaccharide.

ChitoFlex. A stuffable wound dressing conducive to narrow wound tracks.

Combat Gauze. Combat Gauze™ is a 3-inch x 4-yard roll of sterile gauze. The gauze is impregnated with kaolin, a material that causes the blood to clot.

Direct Pressure. Pressure applied directly to a wound, usually with sterile, low-adherent gauze between the wound and source of bleeding.

Field Dressing. A casualty's dressing applied to a wound to control hemorrhaging.

QuikClot. Emergency dressing, combat gauze, interventional bandage, QuikClot ACS+™, QuikClot 1st Response™. When QuikClot® comes into contact with blood in and around a wound, it takes in the

smaller water molecules from the blood. The larger platelet and clotting factor molecules remain in the wound in a concentrated form. This promotes rapid natural clotting and prevents severe blood loss.

None. Check if no hemorrhage control measures.

Unknown. Check if hemorrhage control measures are unknown.

Other. Describe the not otherwise specified hemorrhage control measure.

2.4 PREHOSPITAL WARMING. Check all that apply.

HPMK. Hypothermia Prevention and Management Kit. Check only if all three components were used: Hat/Hood, Activated Liner, and Outer Shell.

If Other. Describe the not otherwise specified warming device.

2.5 PREHOSPITAL MEDS. Enter medication, dose and route.

2.6 PREHOSPITAL INTERVENTIONS. As stated.

IO Infusions. Intra-osseous administration of fluids

IV Fluids. Intravenous administration of fluids

E-Collar. Elizabethan collar. One of a number of devices placed around the neck of a MWD to prevent licking or chewing at a wound or device. May be a commercial product or a bucket with the bottom removed.

Pain Scale. See Table 1 for the explanation of how to determine pain in a MWD

CPR. Cardiopulmonary resuscitation

3.0 PRIMARY ASSESSMENT

3.1 VITALS. As stated. For Pain Scale, enter level that you estimate the dog to be experiencing. Zero indicates the least pain; four is the most severe pain. See Table 1.

TABLE 1. CANINE PAIN SCALE

Score	Behavioral	Palpation	Body Tension
0	Comfortable when resting	Nontender to wound palpation	Minimal
1	Slightly unsettled or restless	Reacts to wound palpation	Mild
2	Uncomfortable at rest, whimpers, licks at wound	Flinches, whimpers, cries	Mild to Moderate
3	Unsettled, crying, groaning, biting, chewing wound	Increased respiratory rate, sharp cry, growl	Moderate
4	Constantly groaning or screaming when unattended, may bite wound	Cries at non-painful palpation, may react aggressively	Moderate to Severe

3.2 NEURO / MENTAL STATUS. As stated. If Other, describe the not otherwise specified.

HYPERACTIVE. Stressed, overly-excited MWD that is alert and conscious but will not follow commands due to repeated panting, pacing and/or aggression. MWD may exhibit frantic searching behavior or excessive, unfocused aggression. Special care should be taken when handling a hyperactive MWD to avoid being bitten.

ALERT. Characterized by a normal level of consciousness. The MWD responds to external stimuli and is able to follow commands when asked.

SEDATED. As stated. The MWD has been administered sedative medication but was alert or hyperactive

before administration.

DEPRESSED. Characterized by a conscious but lethargic state. The MWD is relatively unresponsive to the environment and tends to sleep when undisturbed. Often caused by systemic problems like fever, anemia or metabolic disease. When associated with a primary brain problem, indicates diffuse cerebral cortex disease.

DISORIENTED. The MWD can respond to its environment but does so in an inappropriate manner. Special care should be taken when handling a disoriented MWD to avoid being bitten.

STUPOR. Characterized by an animal that tends to sleep when undisturbed, and that is not arousable with gentle stimuli like sound or touch. The MWD will respond slightly to painful stimuli and have some voluntary movements.

COMATOSE. Characterized by a state of deep unconsciousness, where the MWD cannot be aroused even with significant painful stimuli. Simple reflexes may still be intact and their presence should not be confused with level of consciousness.

MGCS. Modified Glasgow Coma Scale. See Table 2. Score interpretation: 3 – 8 Grave; 9 – 14 Guarded; 15 – 18 Good.

TABLE 2. CANINE MODIFIED GLASGOW COMA SCALE

Level of Consciousness	**Score**	**Pt Score**
Occasional periods of alertness and responsive to environment	6	
Depression or delirium, capable of responding to environment but response may be inappropriate	5	
Stupor, responsive to visual stimuli	4	
Stupor, responsive to auditory stimuli	3	
Stupor, responsive only to repeated noxious stimuli	2	
Coma, unresponsive to repeated noxious stimuli	1	
Motor Activity		
Normal Gait, normal spinal reflexes	6	
Hemiparesis, tetraparesis, or decerebrate activity	5	
Recumbent, intermittent extensor rigidity	4	
Recumbent, intermittent extensor rigidity with opisthotonus	3	
Recumbent, constant extensor rigidity with opisthotonus	2	
Recumbent, hypotonia of muscles, depressed or absent spinal reflexes	1	
Brainstem Reflexes		
Normal pupillary light reflexes and oculocephalic reflexes	6	
Slow pupillary light reflexes and normal to reduced oculocephalic reflexes	5	
Bilateral unresponsive miosis with normal to reduced oculocephalic reflexes	4	
Pinpoint pupils with reduced or absent oculocephalic reflexes	3	
Unilateral, unresponsive mydriasis with reduced or absent oculocephalic reflexes	2	
Bilateral, unresponsive mydriasis with reduced or absent oculocephalic reflexes	1	

3.3 HYPO / HYPERTHERMIA CONTROL MEASURES. As stated. Other includes Body Bag.

3.4 AIRWAY. As stated.

OPA. Oral Pharyngeal Airway

BVM. Bag-Valve-Mask (Ambu bag)

General Instructions for Canine Treatment and Resuscitation Record

3.5 BREATHING. As stated.

3.6 NOTES. As stated.

3.7 CIRCULATION. As stated. Use caution when assessing the mucous membranes of a MWD. If unsedated or variably conscious, ask the handler to show you the mucous membrane color and perform the CRT evaluation. Also consider using an alternate location to approximate CRT. The mucosa of the conjunctiva, prepuce or vulva are acceptable alternative locations to evaluate CRT.

4.0 SECONDARY SURVEY

4.1 HEAD / NECK ENT. As stated.

JVD. Jugular Venous Distention

NR. Non-Reactive

4.2 HEART.

Rhythm. As stated. If Other, describe not otherwise specified rhythm.

NSR. Normal Sinus Rhythm

PEA. Pulseless Electrical Activity

V-Fib. Ventricular Fibrillation

V-Tach. Ventricular Tachycardia

Pulses. Enter S, W, D, A as appropriate. Doppler includes non-palpable, but detected with Doppler. Absent means no pulse, non-palpable and not detected with Doppler.

4.3 ABDOMINAL. As stated.

FAST. Focused Assessment with Sonography for Trauma. Check + (plus) if fluid present.

Check – (minus) if no fluid present. Check in the appropriate block if fluid is identified in

the evaluated quadrant. Leave blank if not performed.

DH. Diaphragmatic-Hepatic

CC. Cysto-Colic

SR. Spleno-Renal

HR. Hepato-Renal

4.4 EXTREMITIES. Check all that apply. To evaluate for Motor in an extremity: once the MWD has been cleared for spinal fracture, then assist to stand if necessary and evaluate each leg for motor as the dog is walked. If the MWD cannot be walked, then touch each paw and evaluate the response. While testing a recumbent dog, do not confuse the withdrawal reflex with motor function. To evaluate for Sensation in a MWD: superficial pain can be elicited by gently pinching between the toes and watching for a head turn or growl; deep pain is assessed by clamping a digit firmly with hemostats until a response is seen. For Pulses Present (positive) enter S, W, D, or A. Doppler includesnon- palpable, but detected with Doppler. Absent means no pulse, non-palpable and not detected with Doppler.

4.5 ALLERGIES. Check one. NKDA is No Known Drug Allergies. If Other, describe not otherwise specified allergy.

4.6 CURRENT MEDICATIONS. As stated. Current Meds: List medication, dose and route.

4.7 MEDICAL HISTORY. As stated.

4.8 PROCEDURES. As stated. Hemorrhage Control Measures. Refer to Prehospital Hemorrhage Control Measures.

NOTE: In the 'performed by' block, in addition to name, record the Title / AOC / MOS / Rate of the person performing each intervention.

ET Intubation. Endotracheal Intubation. List endotracheal tube size if used. List tracheostomy tube size if used. Check block if End Tidal CO2 (ETCO2) changes post-intubation. Check block if patient has bilateral breath sounds (BBS) post-intubation.

General Instructions for Canine Treatment and Resuscitation Record

Chest Tube. 75% of MWDs have a fenestrated mediastinum so both sides of the chest should be tapped if there is significant pneumothorax.

4.9 VENT SETTINGS.

MODE. Manual or Mechanical

FiO2. Fraction of inspired O2. Start at 100% then reduce to <60%

Rate. Number of breaths delivered per minute. For MWDs, set between 8 – 20 bpm to maintain end tidal CO2 between 35 – 45 mmHg

PEEP. Positive End-Expiratory Pressure. For normal lungs 0 -2 cmH2O; for abnormal lungs 2 – 8 cmH2O

TV. Tidal Volume. To calculate tidal volume in a MWD: 15 x BW (kg) = mL TV

Notes. As stated

4.10 INTRAVENOUS / INTRAOSSEOUS ACCESS AND FLUIDS / BLOOD PRODUCTS. As stated. Initials: Legible initials of person who performed task. Enter time as stated.

4.11 MEDICATIONS. As stated. Initials: Legible initials of person who performed task.

4.12 LABS. As stated. Enter time as stated.

CBC. Complete Blood Count

Chem 7. Actual test will vary based on location and available equipment. Typically includes Sodium (Na), Potassium (K), Chloride (Cl), Bicarbonate (HCO3), Blood Urea Nitrogen (BUN), Creatinine (Cr), and Glucose

Chem 12. Actual test will vary based on location and available equipment. Typically includes the tests in a CHEM 7 plus Alkaline Phosphatase (ALP), Alanine aminotransferase (ALT), Aspartate aminotransferase (AST), Bilirubin, Total Protein, Albumin and Calcium (Ca).

H&H. Hematocrit and Hemoglobin

ABG. Arterial Blood Gas

VBG. Venous Blood Gas

PT / PTT. Prothrombin Time / Partial Thromboplastin Time

INR. International Normalized Ratio

U/A. Urinalysis

4.13 CT. As stated. Enter time as stated.

4.14 X-RAY. Enter time as stated.

4.15 PENDING STUDIES. Record any additional tests that have been ordered or completed if there is not adequate space in 4.12 LABS, 4.13 CT or 4.14 X-RAY.

4.16 RESULTS. As stated. Excludes results for labs, CT and X-Ray that should be recorded in Part II, Section 2 Laboratory Results and Section 3 X-RAYS and CT

4.17 VITAL SIGNS. As stated.

ICP. Intracranial Pressure Measurement

4.18 DISPOSITION. Describe patient disposition. If death, complete Part II, section 8.3 Death Information. For mode of transport, refer to section 1.4 Mode of Arrival. If no additional information will be completed on this form, refer to the Completion Instructions on Page 10 for instructions on how to finalize and submit this form.

VMCE. Veterinary Medical Center Europe

4.19 NOTES. Enter additional information relevant to the patient's nursing care.

PART II: VETERINARIAN / PHYSICIAN H&P

GENERAL INSTRUCTIONS:

- To be completed by the veterinarian / trauma physician providing care for the patient.
- Time Zones: Record all time local 24 hour military format, hh:mm

General Instructions for Canine Treatment and Resuscitation Record

- A + (plus sign) means positive test result; a - (minus sign) means negative test result.
- Record date on top of each page. The date should be the day when care is initiated. If the dog receives multiple days of care, use a new, correctly dated form each day.

PATIENT IDENTIFICATION (at bottom of each page). As stated.

NAME. Name of the Military Working Dog (MWD)

TATTOO. Tattoo identifier (located on the inner surface of the MWD's left ear)

MICROCHIP #. Nine, 12 or 15 digit number specific to the MWD. Record if known or scanner available

DOB. Date of Birth as listed on the record or in the Remote Online Veterinary Record (ROVR)

AGE. Dog's age in years

GENDER. Male, Female, Neutered (used for both genders)

BREED. Dog's breed as listed on the record or in ROVR. Recognized abbreviations are acceptable (e.g. German Shepherd Dog – GSD, Dutch Shepherd – DS, Belgian Malinois – B Mal, Labrador Retriever – Lab)

MWD TYPE. MWD's type of service, e.g. PEDD, SSD, MPC, IEDD

HANDLER NAME. Name of the person accompanying MWD

DEPLOYED / ASSIGNED UNIT. MWD's owning unit

VET / TECH / HCP NAME. Name of the person responsible for the care of the MWD.

VET / TECH / HCP SIGNATURE. Signature of the responsible provider completed after reviewing the form for accuracy and completeness.

FACILITY NAME. Record your VTF or MTF unit identifier

FACILITY LOCATION. Record FOB, COB, or geographic site

1.0 HISTORY & PHYSICAL – INJURY DESCRIPTION

1.1 ARRIVAL. As stated.

1.2 TRIAGE CATEGORY. Check one. Refer to 1.7 for definitions from Part I Animal Care Technician / Nursing Flow Sheet.

1.3 CHIEF COMPLAINT, HISTORY AND PRESENTING ILLNESS. As stated.

1.4 INJURY DESCRIPTION. As stated. Annotate on the diagram using the appropriate injury abbreviation. Doppler includes non-palpable, but detected with Doppler. Absent means no pulse, non-palpable and not detected with Doppler. Calculate %TBSA using the guide in section 1.8.

1.5 HISTORY AND PHYSICAL. As stated. Interventions Prior to Arrival is any intervention performed in a prehospital or transferring facility.

1.6 PRE / INITIAL PROCEDURES / DIAGNOSTICS. As stated. Pre means prior to arrival.

Pericardial FAST. Check if presence of fluid or free air. Describe findings as needed.

Thoracic FAST. Check if presence of fluid or free air at Left or Right Chest Tube Site (CTS).

Pericardiocentesis. Check block if performed and record volume of fluid obtained in the space below to distinguish from fluid or blood obtained from the thorax.

DPL. Diagnostic Peritoneal Lavage. Describe technique, locations attempted / performed and findings.

Serial AFAST. Refer to Part I, section 4.3 Abdominal for location definitions.

Front / Rear Extremities. As stated. Also record and describe if other type of bandage is placed.

Seizure Protocol. Control seizures that develop with diazepam or midazolam (0.3 mg/kg; IV, IO, or intranasally), repeated every 15-30 minutes if necessary. If available, give phenobarbital (15 mg/kg IV or IO) loading dose, and 2.5 mg/kg IV every 12 hours thereafter if seizures persist or status epilepticus develops.

Central Line. Describe location, catheter size and number of ports.

Intraosseous / Intravenous Catheter. Describe location and catheter size.

General Instructions for Canine Treatment and Resuscitation Record

1.7 PUPILS / VISION. As stated.

1.8 BURN. As stated. Describe the cause of burn.

% TBSA. Percent of Total Body Surface Area affected. Head: 9%; Thorax: 18%; Abdomen: 18%; Forelimb: 9% each; Hindlimb: 18% each.

Super. Superficial – First Degree.

Super PT. Superficial Partial Thickness – Second Degree.

Deep PT. Deep Partial Thickness – severe Second Degree.

Full. Full Thickness – Third Degree if injury limited to the skin and subcutaneous tissues. Fourth Degree if the burn involves muscle and bone.

1.9 EXTREMITIES. As stated. Evaluate and record Motor, Sensory and Range of Motion (ROM) for each extremity.

2.0 LABORATORY RESULTS

2.1 CBC. As stated.

2.2 CHEMISTRY 7/12 (14). As stated. Refer to Part I, Section 4.12 for abbreviation descriptions.

2.3 PT / PTT / INR. Prothrombin Time / Partial Thromboplastin Time / International Normalized Ratio. As stated.

2.4 BLOOD TYPE. Record if patient is DEA 1.1 positive or negative. Record full blood type if known.

2.5 VBG / ABG. Venous Blood Gas / Arterial Blood Gas. As stated.

2.6 URINALYSIS. As stated.

SpGr. Urine Specific Gravity. Canine USG should be measured on a refractometer, as urine test strips are not always accurate.

LEU. Leukocytes

PRO. Protein

GLU. Glucose

KET. Ketones

UBG. Urobilinogen

BIL. Bilirubin

HGB. Hemoglobin

2.7 OTHER LABS. Record any additional labs performed and appropriate results.

3.0 X-RAY AND CT

3.1 CT OBTAINED. As stated.

3.2 X-RAYS OBTAINED. As stated.

3.3 FOREIGN BODY. Check all that apply. Collect the foreign body and save. More guidance will be forthcoming on where to send.

3.4 PENDING STUDIES. As stated.

3.5 RESULTS. As stated. Include TEG / Rotem results if performed. Refer to the CPG to evaluate canine TEG results.

4.0 IMPRESSION / ASSESSMENT

Enter impressions and findings.

4.1 SEVERITY. (mark the most appropriate)

4.2. IMPRESSION/ASSESSMENT COMMENTS (fill in as appropriate)

5.0 DIAGNOSES

Enter diagnoses and findings, up to 12. If more than 12, record the most life-threatening findings.

General Instructions for Canine Treatment and Resuscitation Record

6.0 PLAN

6.1 PLAN. Enter the treatment plan and any additional procedures that were or will be performed.

7.0 DNBI / NBI CATEGORY

Check all Disease Non Battle Injuries/Non Battle Injuries that apply. Describe any injury not otherwise specified.

8.0 CAUSE OF DEATH

If death, complete all appropriate sections. Leave blank if patient is alive.

8.1 ANATOMIC. As stated. If Other, describe not otherwise specified anatomy.

8.2 PHYSIOLOGIC. As stated. If Other, Specify, describe not otherwise specified physiology.

MOF. Multi Organ Failure

CNS. Central Nervous System Failure

8.3 DEATH INFORMATION.

Euthanized. Record medication(s) used, volume administered and route. Compete Canine Death Certificate (DD Form 1743).

Necropsy by DVM. Record necropsy date and time (local). Record time between death and start of necropsy if known. Estimate time if unknown.

Gross Pathology Report. Annotate if a gross necropsy was performed, and gross pathology report (DD Form 1626) was completed, and if samples were submitted to the Joint Pathology Center (JPC) or other pathology center. Record where the tissue samples were submitted and date of submission if known.

Death Remarks. Annotate any other information that may be pertinent to the patient's case.

CANINE TREATMENT AND RESUSCITATION RECORD COMPLETION AND SUBMISSION

- After the form has been completed, it should be reviewed by the responsible HCP listed in the Patient Identification block for completeness and detail. The responsible HCP should then sign each page.
- The signed form needs to be submitted to the DOD Military Working Dog Veterinary Services DAILY by clicking on one of the 'Submit by Email' buttons located on the bottom of each page. If the button does not work, then submit the form to dog.consult@us.af.mil. The subject line should include the MWD Name, Tattoo and Date, i.e. 'Canine Treatment and Resuscitation Record MWD Ayaks L332 16 August 2018'. For US Special Operations Command canines, the Canine Treatment and Resuscitation Record(s) will be filled out and returned to the handler or operator. The handler or operator will route the record(s) to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.
- A printed copy of each signed form MUST be included in the MWD's paper record to ensure continuity of care, especially if the dog will be transferred to another level of care.
- A completed copy of the record will be uploaded into the MWD's ROVR record when access is available. This should happen in theater if possible, but if ROVR access is not available, then all records need to be uploaded at the first Role III facility or at the MWD's home station veterinary clinic.
- To upload a form in ROVR:
    - Open the MWD's record, select Imported Files from the Patient Tools menu on the right
    - Select the Upload File button in the upper left hand corner of the screen
    - Find the appropriate file by selecting the browse button, then complete each field. Document date is the date listed on the Treatment and Resuscitation Record. Document Type should be 'Other' and Specialty should be 'Emergency Care.' In the Comments, record as 'Canine Treatment and Resuscitation Record'. Select Upload to finish.
    - Repeat as necessary for each completed record.

Naval Aviation
Medical Treatment Protocols

APRIL 2019

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PROTOCOLS APPROVAL

The Search and Rescue Medical Program Directors (MPD) have approved this document as Standing Orders of patient treatment protocols for Rescue Swimmers (RS), EMT-Basics, Search and Rescue Medical Technicians (SMT), Paramedics (EMT-P), and Critical Care Paramedics. Medicine is a practice, ever changing, and requires updates. To keep up with medical advancements, each section should be reviewed and updated as appropriate; at a minimum, every 2 years or upon change of the Medical Director. Changes and revisions will be issued only after approval from the Medical Director.

This document is *not* intended to be a comprehensive patient care manual. Rather, it specifies standard operation procedures (SOP) and treatment protocols to operate under emergency medical conditions without the direct supervision of a Medical Director.

The introduction and Administrative sections establish the standard by which personnel shall abide. All other sections are designed for use by basic and advanced providers. While they should be followed, there is no substitute for logical thinking, common sense, and professional performance by the provider employing them. Mission requirements or a patient's emergency condition may require the provider to deviate from the stated protocol without the benefit of immediate access to medical direction. Under such circumstances, deviations should be limited to the provider's level of training, common sense, and the dictum "Primum Non Nocere" ("First, do no harm").

Each treatment protocol presents the basic life support tasks separate from the advanced life support tasks. This was done so providers have a sensible order of patient treatment. In the event a provider responds to an unusual case, or where the illness or injury does not fall into a treatment protocol, the provider will seek directives from Medical Control. If Medical Control is unavailable, the provider shall apply aforementioned skills with common sense and seek to maintain Airway, Breathing, and Circulation. Remember, start with the basics and fall back on the basics.

CDR Benjamin Walrath MD/USN NPI# 1356497168 _____ Date: 14 DEC 2017

LCDR Paul Roszko MD/USN NPI# 1639499544 _____ Date: 14 DEC 2017

DEPARTMENT OF THE NAVY
COMMANDER, HELICOPTER SEA COMBAT WING ATLANTIC
610 "A" STREET STE 150
NORFOLK, VIRGINIA 23511-4011

IN REPLY REFER TO:
3130
Ser N00/002
12 Jan 18

From: Commander, Helicopter Sea Combat Wing Atlantic
To: LCDR Paul J. D. Roszko, MC, USN

Subj: DESIGNATION AS SEARCH AND RESCUE MEDICAL PROGRAM DIRECTOR FOR COMMANDER, HELICOPTER SEA COMBAT WING ATLANTIC

Ref: (a) OPNAVINST 3130.6E
(b) OPNAVINST 3710.7

1. Per reference (a), you are hereby designated as the Search and Rescue (SAR) Medical Director for the SAR Medical Technician Program for Commander, Helicopter Sea Combat Wing Atlantic.

2. You are to familiarize yourself with the functions and responsibilities listed in references (a) and (b).

3. This designation will remain in effect until your detachment or unless otherwise revoked.

A. M. WORTHY

DEPARTMENT OF THE NAVY
COMMANDER
HELICOPTER SEA COMBAT WING PACIFIC
NAVAL BASE CORONADO
P.O. BOX 35796
SAN DIEGO, CALIFORNIA 92135-7096

1200
N00
2 Apr 18

From: Commander, Helicopter Sea Combat Wing Pacific
To: CDR Benjamin D. Walrath, MC, USN

Subj: DESIGNATION AS SEARCH AND RESCUE MEDICAL PROGRAM DIRECTOR FOR HELICOPTER SEA COMBAT WING PACIFIC

Ref: (a) OPNAVINST 3130.6E
(b) OPNAVINST 3710.7V

1. Per reference (a), you are hereby designated as the Search and Rescue (SAR) Medical Director for the SAR Medical Technician Program for Helicopter Sea Combat Wing Pacific.

2. You are to familiarize yourself with the functions and responsibilities listed in the cited references.

3. This designation will remain in effect until your detachment or unless otherwise revoked.

K. M. KENNEDY

"PRIVACY ACT PROTECTED – FOR OFFICIAL USE ONLY"

INTRODUCTION TO NAVAL AVIATION MEDICAL TREATMENT PROTOCOLS:

This document has been prepared for use by Emergency Room Physicians, Aviation Medical Director's / Naval Hospital flight surgeons, and Search and Rescue Medical Technicians (SMT), who are engaged in the conduct of Search and Rescue with Air Medical Transport (AMT) operations, Aero-Medical Evacuation (MEDEVAC), and Tactical Evacuations (TACEVAC).

This document is intended to provide a consistent framework of medical treatment guidelines for Naval Aviation Search and Rescue, as discussed on the following page. The document has been created to reflect current prehospital medical trends. It has been adapted for use by the Search and Rescue (SAR) Medical Technician (SMT/NEC L00A), SMT Paramedics, Rescue Swimmers, and EMT-Rescue Swimmers providing medical care. No protocol template can address every eventuality or medical condition in a universally accepted format. The basic protocols provided in this document will, however, provide a consistent set of medical treatment standards that can be delegated from the Medical Director to the infield providers. Protocols provide consistent standards for training and performance improvement monitoring: they are one of the cornerstones of every EMS system development.

The SMTs possess varying levels of experience from the recently qualified SMT with National Registry of Emergency Medical Technician (NREMT)-Basic (NREMT) certification up to the SMT with NREMT-Paramedic certifications. Between the Basic EMT and the Paramedic lies the nebulous EMT intermediate (which has no consistent skill set from state to state). Each SMT possesses a different skill proficiency level depending on his/her previous experience and patient care history. Unlike the civilian Paramedic who uses his/her skills on a daily basis, the SMT may only use his/her skills occasionally for actual patient care in the station SAR environment. All SMTs have received training and certifications in Intravenous therapy, however it is encouraged and recommended that all SMTs receive continuing education on ALS classes to include; Advanced Cardiac Life Support (ACLS), Advanced Pre-Hospital Trauma Life Support (PHTLS), Tactical Combat Casualty Care (TCCC), Pediatric Advanced Life Support (PALS), Pediatric Education for the Prehospital Provider (PEPP), Neonatal Resuscitation Provider (NRP) and Operational Emergency Medical Services (OEMS).

The Rescue Swimmers and Rescue Swimmer/EMT possess a base knowledge of first responder/EMT Basic qualification. Their skill set is a tremendous help in the triage, treatment, and turnover of patients. Each Rescue Swimmer/EMT medical capabilities is covered in these protocols.

The intent of these protocols is to allow all of the SAR Members to best utilize the skills that they do currently possess to treat their patients. This is dependent on the validation of any advanced skills (such as endotracheal intubation, cricothyroidotomy, chest decompression, advanced cardiac life support and pharmacology) at the unit level by the Petty Officer designated by the Medical Director or Commanding Officer as the Standardization Petty Officer. SAR Members will perform only those skills with which he/she is proficient. If he/she is not proficient in a skill that he/she has been taught or if he/she is not confident with his/her ability to correctly perform a procedure, he/she will consult his/her Standardization Petty Officer for further training. Regular training and practice will be ongoing, so there should be ample opportunity to become proficient and confident with all of the skills detailed in these protocols!

In practical terms, this means providing care IAW the guidance above without deviation. If there is a needed deviation, your medical director is responsible for any directed deviation during on-line Medical Control. If you provide care outside the scope of your practice during off-line Medical Control, you are personally responsible for any adverse outcome. *DO NOT PROVIDE CARE THAT DEVIATES FROM WHAT YOU ARE TRAINED AND ALLOWED TO DO.*

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II. ADMINISTRATIVE

1. MEDICAL DIRECTOR

The Medical Director should be a licensed physician and Emergency Room physician, or Trauma Surgeon, or EMS Director. The Medical Director will advise the Unit's Commanding Officer on all medical components of the Unit's operations as required by the CO. The Medical Director will also serve as medical control authority for all patient care performed by unit SMTs. The Medical Director will be available for consultation, provide retrospective Quality Assurance/Quality Improvement (QA/QI) review, supervise continuing education (CE) programming, and will serve as a medical liaison between this unit and other services, facilities, and physicians. The Medical Director may delegate his or her authority to the senior SAR Medical Technician (typically Standardization PO) as he or she deems appropriate.

ON-LINE Medical Control: A physician is present at the scene or available through communication. Although this is the ideal and preferred method it is uncommon in most Rescue operations. Order of precedence for on-line medical control:

On scene:
Senior Medical Officer (SMO of Ship)
Senior U.S. Military Physician present on scene
Senior Allied Military M.D. (equivalent to US Military Physician)
Civilian M.D. who can prove credentials and assumes responsibility
Senior Military Physician Assistant
Senior SOCM / 18D

Off scene:
U.S. Military Physician in direct contact via audio/visual communication

Off-line Medical Control: Contact with a Physician is impossible or impractical. Care is based on approved protocols and procedures. This is the most common scenario.

In Off-line control situations,

Note: These sources cover the vast majority of care you will provide. Instances where deviation may occur more frequently would be in remote situations where certain medications are not available, and the local medical authority has directed the use of locally available meds, and has provided the adequate in-service education with proper documentation. Also, certain regions may have diseases and treatments that are endemic and require unique care that should be added to the protocols in that area of operation.

2. STANDING ORDERS/TREATMENT PROTOCOLS

Designated SMTs will maintain professional certifications, continuing medical education, and military credentials in accordance with OPNAVINST 3130.6 series, the National Registry of Emergency Medical Technicians, and local command directives.

II. ADMINISTRATIVE

A. Skill Sets:

Skill	Rescue Swimmer (RS)	RS / EMT	SMT	EMT-P
Airway				
Oral/Nasalpharyngeal Airway		x	x	x
L.M.A or Combi-tube			x	x
King Airway			x	x
Magill Forceps Use			x	x
CPAP/Bipap			x	x
Cricothyrotomy			x	x
Chest Decompression			x	x
Finger Thoracotomy / Chest Tube				FP-C / TP-C
Automated Ventilator			x	x
Bag Valve Mask	x	x	x	x
Pocket Mask	x	x	x	x
Circulatory Support				
Peripheral IV			x	x
Intraosseous Cannulation			x	x
External Jugular Cannulation			x	x
Glucometry		x	x	x
Automatic External Defibulator	x	x	x	x
Defibrillation - Automatic/Manual			x	x
Synchronized Cardioversion			x	x
Pacing			x	x
Vital Signs - Automatic/Manual		x	x	x
Medications				
Assisted Medications		x	x	x
Inhaled Medications - Nebulizer			x	x
IM Medications			Limited	x
IV Medications			Limited	x
IO Medications			Limited	x
PO Medications		x	x	x
SL Medications			x	x
SQ Medications			x	x
Transdermal Medications			x	x
Blood Products				x

II. ADMINISTRATIVE

A. Skill Sets:

All provider levels shall perform

Only qualified SMT's shall perform

SMT's are permitted to perform all skill sets

Only qualified Paramedics shall perform

Paramedics' are permitted to perform all skill sets up to this level.

II. ADMINISTRATIVE

B. SMTs who are QUALIFIED and designated are authorized to utilize, at the discretion of the Medical Director, the following medications:

***** Medications that Highlighted are only for SMT-Paramedic use**
++ Controlled Substance ++

1) Administration of the following medications according to treatment protocols:

Acetaminophen (Tylenol)
Activated Charcoal
Adenosine (Adeonocard)
Albuterol 0.5%
Amiodarone
Aspirin
Atropine Sulfate
Calcium Chloride
Calcium Gluconate
Cefazolin Sodium (ANCEF)
Ceftraixone (Rocephin)
Dextrose 25% / 50%
Dexamethasone
Diamox
Diazepam (Valium) ++
Diltiazem ++
Diphenhydramine (Benadryl)
Dopamine
Ertapenem (INVANZ)
Erythromycin Ophthalmic Ointment
Etomidate
Epinephrine
Fentanyl++
Flumazenil (Romazicon)
Furosemide (Lasix)
Glucagon / Insta Glucose
Hetastarch
Ipratropium
Ketamine ++
Ketorolac
Lactated Ringers (LR)
Lidocaine (Xylocaine)
Lorazepam (Ativan) ++
Magnesium Sulfate 10%
Meloxicam (Mobic)
Methylprednisolone
Midazolam (Versed) ++
Moxifloxacin (Avelox)
Morphine Sulfate ++
Naloxone (Narcan)
Nitroglycerin SL spray / tablets
Ondansetron (ZOFRAN)
Oxymetazoline (Afrin)
Oxygen
Promethazine
Rocuronium
Sodium Bicarbonate
Sodium Chloride 0.9% (NS)
Succinylcholine
Vecuronium
Vasopressin
Thiamine
Terbutaline
Tranexemic Acid (TXA)

2) The following are to be utilized only if the SMT possessed at EMT-P and or FP-C certification. If the SMT does not possess the certification, the SMT shall have at a minimum a nurse or higher during transport.

Blood Products
Fresh Frozen Plasma (FFP)
Freeze Dried Plasma

II. ADMINISTRATIVE

3. Principles of Medical Care:

1. MARCH PAWS: A pneumonic device used to cover the vast majority of care required during medical/tactical field care and medical/tactical Evacuation. It covers the care of any medical/trauma patient. Other than the **"M"**, it covers the care for most medical patients since it is just a variation of the ABC'S. This approach allows for the SAR medical community to treat in an organized manner ensuring he/she doesn't neglect any treatment in the event of a break in care.

M – Massive bleeding
A – Airway
R – Respirations
C – Circulation
H – Head and hypothermia
P – Pain
A – Antibiotics
W – Wounds
S – Splinting

The approach/Treatments below include practices & principles from the NREMT, ATLS, TCCC, PHTLS/ITLS, data from the OCO, Joint Trauma Registry, and past experiences.

2. Principle of the assessment**:**

a. PPE
b. Scene safety & security
c. Mechanism of injury/illness (MOI)
d. # of patients
e. Call for additional resources as applicable
f. General impression
g. **MARCH**:
   - **M** – Tourniquet, hemostatic gauze, pressure dressing, pelvic sling/junctional tourniquet, suture/staple, clamp, direct pressure, junctional hemorrhage device, elevate.
   - **A** – Chin lift/Jaw thrust, recovery position, sit up and lean forward position, NPA, OPA, supra-glottic device, ET tube, cricothyrotomy.
   - **R** – Chest seal, needle decompression, BVM, SpO_2, finger or tube thoracostomy.
   - **C** –Diagnose (Weak or absent radial pulse, decreased mental status) and treat shock.
   - **H** – Head; diagnose increased intracranial pressure (AVPU, pupils, posturing, irregular respirations, $EtCO_2$). Treatment; Secure the airway, IV/IO. Keep B/P >100, SpO_2 >93%, $EtCO_2$ 30-35 mmHg.
   - **H** – Hypothermia; Dry patient, insulate from the ground, casualty blanket, HPMK, hat.

h. Vital Signs – AVPU, HR, BP, RR, SpO_2%, $EtCO_2$%, Temp. Blood Sugar, 4 Lead / 12 Lead (as applicable)
i. Secondary survey (**PAWS**) – head to toe: DCAP-BTLS, LOBOS, TIC, step in/off
   - **P** – Pain Meds as applicable per protocol.
   - **A** – Antibiotics – PO or IV/IO, for all open combat wounds.
   - **W** – Wounds – clean (remove debris, irrigate) and dress.
   - **S** – Splinting- Perform orthopedic related care, address ortho/PMS; SAM, KTD, spinal immobilization (per protocol), rigid eye shield.
j. Reassess – every 5 minutes for critical / 15 minutes for non-critical / as needed / feasible.
k. Document – Casualty card, medical report.
l. Package for evacuation / transport.

II. ADMINISTRATIVE

4. **Assessment Checklist:**

Scene Size Up

- Scene safety / security
- BSI / PPE
- Determine the mechanism of injury / illness (MOI)
- Determine the # of patients (in case triage is necessary)
- Request additional help if necessary, determine availability of resources
- Verbalize initial impression: "Sick or not Sick

Primary Assessment

- C-Spine as needed unless ruled out
- AVPU
- Massive Hemorrhage – Visualize and feel (sweep) for life threatening hemorrhage:
  - All 4 extremities
  - Junctional Sites (Neck, Axillae, Groins)
  - Torso and back
  - Pelvic stability
- Airway - Open and maintainable (LOBOS)
- Respirations – Assess rate, depth, quality, auscultate lung sounds, apply finger pulse oximeter (as needed or available)
  - Look: Chest rise and fall, paradoxical motion, chest wall injuries.
  - Listen: if possible with a stethoscope.
  - Feel: chest wall: rips, subcutaneous air, holes or defects.
- Circulation – Diagnose shock (Radial / carotid pulse, assess skin color and temp, cap refill).
  - Reassess bleeding control interventions
  - Check pulses for: Rate, strength, and quality
- Head – Rule out severe intracranial pressure (TBI) by identifying mental status, pupils, posturing or snoring respirations.
  - Glasgow Coma Score (GCS)
  - Assess Cranial Nerves
- Hypothermia – Dry and cover patient, use HPMK or blanket/Emergency blanket, insulate from ground.
- Transport decision

Secondary Assessment

- Vital signs - AVPU, HR, BP, RR, SpO_2%, $EtCO_2$%, Temp. Blood Sugar, 4 Lead / 12 Lead (as applicable)
- Head to toe examination:
  - Head: inspect head and face for DCAP-BTLS, reassess airway (LOBOS), ears for drainage, pupils (PERRLA), nose for bleeding and stability, jaw for stability.
  - Neck: Assess for JVD, Subcutaneous air, hematoma, Tracheal deviation, C-Spine deformity / tenderness / Step-off/in.
  - Shoulders/Clavicles: DCAP-BTLS
  - Chest: Expose and inspect, DCAP-BTLS, Reassess the same as primary assessment
  - Abdomen: Normal= soft, flat, non-tender. Assess for tenderness, rigidity, distension, and pulsating masses (TRD-P)
  - Pelvis: Check pelvis once (do not rock), document status of genitals if amputations, priapism.
  - Extremities: DCAP-BTLS, PMS, strength and ROM.
  - Spine: Only log roll if appropriate, DCAP-BTLS, step-off/in.

- Secure to spine board / rescue litter as required.
- Pain – Pain regimen per protocol
- Antibiotic – Antibiotic per protocol
- Wounds – identify potential life threatening wounds
- Splint – perform orthopedic related care as needed.
- Reassess airway / interventions after move or litter placement
- Do not delay transport for IV/IO, drug therapy, or non-critical interventions
- S.A.M.P.L.E / O.P.Q.R.S.T as available.

Documentation and Verbal Report

- Verbal Report:
  - Age
  - Time of incident / illness
  - MOI
  - Signs and symptoms
  - Treatment and interventions
- Written Report:
  - C – Chief complaint
  - H – History
  - A – Assessment
  - R – Treatment
  - T – Transport

Prolonged Field or Extended Field Care

SAR Medical Technicians may be put in a positon for caring for injured/ill patients for periods of up to 24 hours. In these situations, refer to protocols as a baseline and seek online medical control whenever feasible or available.

- For these situations, the acronym **HITMAN** should be used:
  - **H** – Hydration, hypothermia, hygiene
    - Hydration – PO / IV/ IO / NG Tube (PRN), Urine output should be approx. 1-1.5ml/kg/HR. Starting maintenance IVF – rate should be approx. 125 ml/hr.
    - Hypothermia – Insulate from the ground, keep warm and dry
    - Hygiene – Prevent sores / roll and pad the patient, keep patient clean and dry.
  - **I** – Infection: Monitor compartment syndrome, change dressings 12-24hrs, antibiotics as per protocol.
  - **T** – Tubes: Neat and tight, continue to suction as needed.
  - **M** – Medications: 6 Rights: Patient, med, dose, time, route, documentation.
    - Monitoring Vitals: If stable, q2-4 h. At a minimum no less than q 12h.
  - **A** – Analgesic: Document pain scale, Pain regime per protocol.
  - **N** – Nutrition: If able, 1500 calorie a day intake.
    - Extremely important for all patients that are alert and oriented and can swallow without difficulty and for the SMT caring for the patient. (Tubed or altered mental status patients should not be given food)

If a patient becomes unstable during any extended care, restart back at the MARCH PAWS phase and reassess history once stability is regained.

II. ADMINISTRATIVE

5. Refusal of medical care and/or transport:

In general, Active Duty military members may not refuse life-saving medical care. Mentally competent adult civilians (including dependents, spouses and retired military members) may refuse medical care, even if refusing medical care endangers their lives. SMT's should make every effort to ensure that patients refusing medical care are aware of the possible consequences of their actions. The patient should be urged to seek other medical care as soon as possible.

• If the patient is unconscious, or unable to make a rational decision (secondary to head injury or any other cause of altered mental status) the principle of ***Implied Consent*** assumes that a normal, rational person would consent to life-saving medical treatment.

• If the patient is a minor or mentally incompetent adult, permission to treat must be obtained from a parent or guardian before treatment can be rendered. If a life-threatening condition exists, and the parent or guardian is unavailable for consent, treatment shall be rendered under the principle of implied consent, as noted above.

• If an alert, oriented patient with normal mental status refuses medical care, then care cannot be rendered. Medical control should be contacted (if possible) if such a situation occurs.

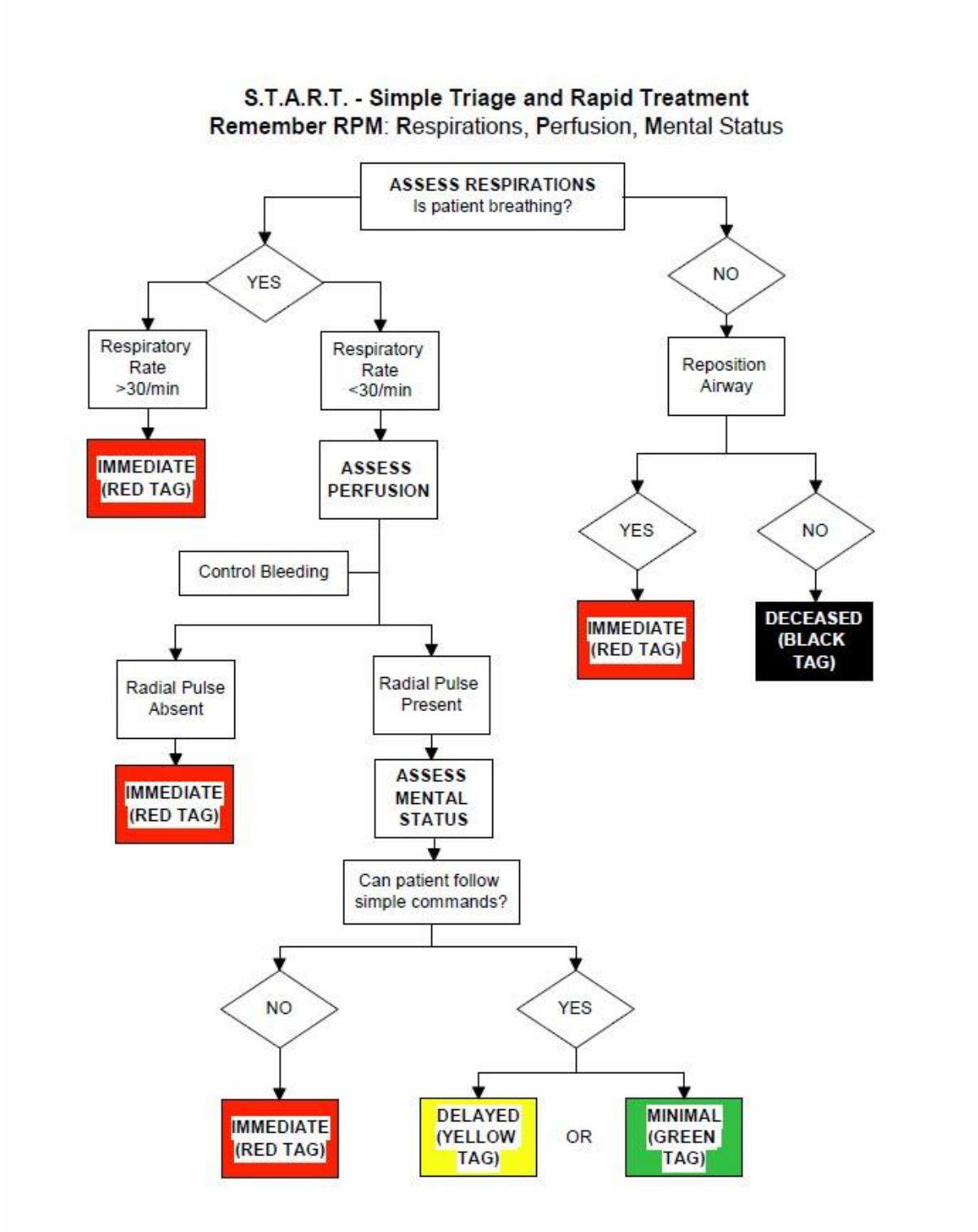
• If a patient refuses medical care the following statement must be written on the medical treatment form and signed by the patient:

"I, THE UNDERSIGNED HAVE BEEN ADVISED THAT MEDICAL ASSISTANCE ON MY BEHALF IS NECESSARY AND THAT REFUSAL OF SAID ASSISTANCE MAY RESULT IN DEATH, PERMANENT INJURY OR IMPERIL MY HEALTH. I REFUSE TO ACCEPT TREATMENT, AND ASSUME ALL RISK AND CONSEQUENCES OF MY DECISION. I RELEASE THE UNITED STATES AIR FORCE AND THE DEPARTMENT OF DEFENSE FROM ANY LIABILITY ARISING FROM MY REFUSAL TO ACCEPT MEDICAL CARE."

- **Note:** The statement must be signed and dated by the patient, and countersigned by a witness. The medical record should completely document that the patient is awake, alert, oriented and has normal mental status. If the patient refuses to sign the form, and still refuses medical care, the patient's refusal to sign should be documented and signed by the treating SMT and preferably by at least one other witness.

II. ADMINISTRATIVE

6. **Triage – S.T.A.R.T Flowchart**



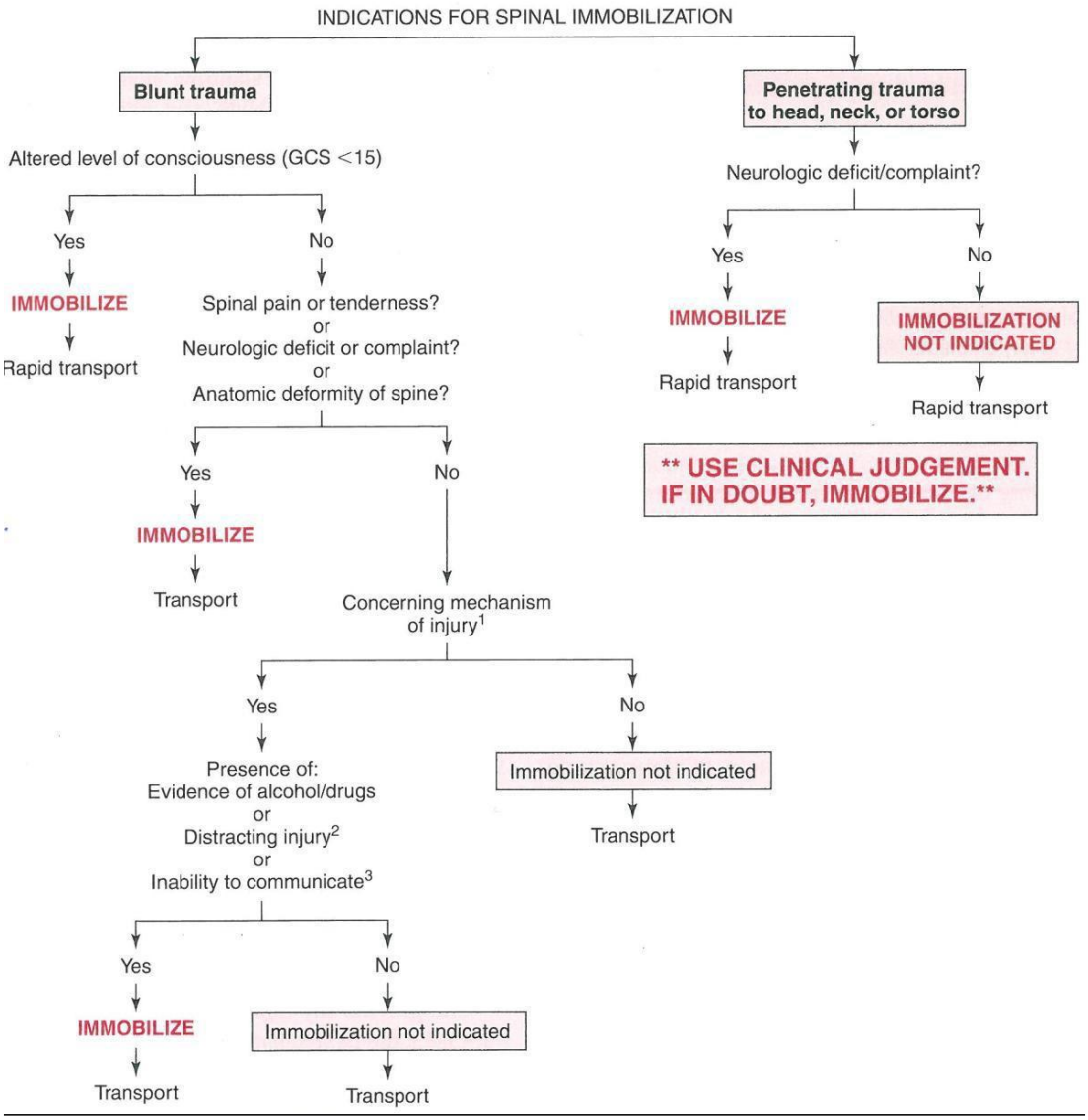
II. ADMINISTRATIVE

7. Spinal Immobilization

Spinal Immobilization is indicated for trauma patients where there is a suspicion of spinal injury or the patient complains of pain associated with the spinal column. Special consideration should be given when the patient age is <8 or >70 years of age.
The provider may decide to forgo spinal immobilization if the following criteria are met:

-No significant mechanism of injury (MOI)
-No loss of consciousness (LOC)
-No altered level of consciousness (LOC)
-Patient is able to communicate and is a reliable historian
-No signs of intoxication
-No distracting injuries
-No midline back or neck pain with or without movement
-No midline pain or tenderness or deformity present in back or neck upon palpation
-No pain present through full range of motion

Risk of spinal immobilization versus benefits should be weighed in special circumstances such as; prolonged extrication from wilderness setting and technical rescue situations. Risks include; emesis with airway compromise, pressure sores, extreme patient discomfort. Index of suspicion for injury should be carefully weighed.



1- Concerning mechanisms of injury

-Any mechanism that produced a violent impact to the head, neck, torso or pelvis
-Incidents producing sudden acceleration, deceleration, or lateral bending forces to the neck or torso (moderate to high speed mva, cars vs pedestrian, explosions, etc.)
-Any fall, especially in elderly patients
-Ejection or fall from any motorized or otherwise-powered vehicle (scooters, skateboards, bicycles, motorcycles, motor vehicles, or recreation vehicles)
-Victims of shallow water diving accidents

2- Distracting Injury

-Any injury that may have the potential to impair the patient's ability to appreciate other injuries, (long bone fractures, visceral injuries, large lacerations, degloving injuries, crush injury, large burns, or any other injury causing acute functional impairment)

3- Inability to communicate

-Any patient who for reasons not specified above cannot clearly communicate so as to actively participate in their assessment (speech or hearing impairment, those who only speak a foreign language, small children, etc.)

8. Altitude Physiology and Patient Transfer

ALTITUDE CONCERNS FOR AEROMEDICAL TRANSFERS:

• **Gas expansion** occurs as altitude above sea level increases. The volume of a gas will roughly double at 18,000' mean sea level (½ sea level atmospheric pressure). This will typically not affect the operational ceiling for the MH-60S during Aeromedical Evacuation operations. Certain conditions and precautions to note:

- **Air embolism / Decompression illness** – This is the only absolute contraindication to transport of patients at altitude. These patients should be transferred at sea level or in an A/C capable of cabin pressurization to sea level.

- **Pneumothorax** – There is little risk of developing a tension PTX due to gas expansion from altitude during typical aeromedical evacuation flights in rotary-wing A/C. However, altitude should be limited when possible to <5,000' MSL. If mission requirements mandate higher altitudes, the use of aeromedical evacuation platforms with pressurized cabins should be considered as applicable and tactically capable. Prophylactic chest tubes (for altitude-related concerns) are recommended for any flights above 10,000' mean sea level.

- **Gastric distention** – Gas expansion does increase the risk of vomiting and, therefore, aspiration. Therefore, all patients with decreased LOC should have an NG / OG tube placed prior to transfer.

- **Head injury** – As with PTX, there is little concern of altitude related elevation of elevated ICP in head injured patients although penetrating intracranial or maxillofacial injuries may set conditions for an entrapped-gas phenomenon with adverse clinical consequences. Any evidence of elevated ICP should result in treatment per guideline. Altitude restrictions do not differ from those listed for PTX. Constant vigilance should be maintained for evidence of elevation of ICP.

- **Eye injury** – Penetrating eye injuries or surgeries may introduce air into the globe. Again, the altitudes obtained for rotary-wing A/C does not pose a risk of elevating the IOP during normal operations.

- **Gas filled equipment** – Medical equipment with gas filled bladders also may suffer from interference at high-altitudes. Primarily, endotracheal tube cuffs should be evaluated at altitude by testing the pressure of the exterior bladder or filled with air. If able, utilize manometer to verify tube pressure. Verify with

supervising physician or flight surgeon before filling endotracheal tube with saline.

• **Flow Rates:** Decreased atmospheric pressure may interfere with IV flow rates and/or pump function. These must be monitored continuously.

• **Invasive Blood Pressure:** Adjust / re-calibrate monitor every 1000' if required based upon monitoring device.

• **Hypothermia:** As altitude increases, the temperature will drop about 3.5° F per 1000 feet. This is further complicated in the H-60 due to rotor-wash, forward air speed, normal lapse rate. Therefore, patients must be protected from hypothermia at all times. This includes use of the Hypothermia Prevention and Management Kit (HPMK), blankets, heaters if available, and closing cabin doors / crew windows during transport.

• **Hypoxia:** Patients are at increased risk of hypoxia during transport at altitude. If transfers are taking place in high-altitude locations, pulse oxygenation should be monitored at all times and the medic / provider should maintain a low threshold for the use of supplemental SpO_2. At no time should the patient's SpO_2 be allowed to go below 92 percent (commercial pulse oximeters read up to 3 percent off, therefore a sat of 91 percent may be seen in a patient who is really at 88 percent.). ***Patients who smoke or have underlying cardiopulmonary disease are at increased risk even at low altitudes.***

• **Dysbarism:** Patients may experience discomfort due to gas expansion in air-filled body spaces (e.g., ears, sinuses, teeth) during ascent. Conversely, patients and aircrew may experience "squeeze" resulting from descent from altitude. These are typically mild during RW transport, however, if severe, altitude should be held and attempts made to alleviate pain and/or slow rate of ascent / descent.

Document procedure, results, and vital signs.

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III. ADULT PATIENT CARE PROTOCOLS

1. ***Airway / Oxygenation / Ventilation***

A. Objectives:

1) When possible, a room air pulse oximetry reading should be obtained and documented.

2) The goal is to maintain SP02 > 94%, $EtCO_2$ 35-45mmHg unless suspected Head Trauma.

3) Establish an airway for all patients who cannot maintain their own.

B. Warnings/Alerts:

1) Failure to use end-tidal C02 monitoring increases the risk of an unrecognized misplaced tube. $EtCO_2$ Shall be used in all Post Intubation, Cricothyrotomy, or king/supraglottic airway's.

2) Failure to confirm tube placement prior to securing or following patient movement may lead to unrecognized tube displacement.

3) Apnea is an absolute contraindication to nasal intubation.

4) Unable to open or effectively ventilate the patient with the inability to clear, two failed Supraglottic/ET airway attempts, or intubation is contraindicated shall warrant the performance of a Cricothyroidotomy.

5) All advanced airway patients shall require at a minimum, a c-collar to prevent dislodgement of the airway device.

C. Medications:

1) Post-intubation Sedation:

a) 2-5mg Valium IV or 2mg Versed IV

APPENDIX A : TRAUMA AIRWAY ASSESSMENT

Trauma Airway Management

Airway Assessment

- All trauma airways are potentially high-risk. Anticipate a difficult airway.
- Identify critical team members and verbalize role assignments.
- Initiate pre-oxygenation (1,2).
- Consider Ketamine (0.5-1.0 mg/kg IV/IO) for delayed sequence intubation if combative or otherwise uncooperative patient (3,4,5).
- Recall that the neutral position ("C-spine stabilization") degrades the laryngoscopic view.

Rapid Sequence Induction (RSI) and Intubation Pathway

1. **Confirm equipment availability and function** IV/IO, suction, self-inflating bag and mask, oxygen source, laryngoscope- direct and video (5), ETT with stylet and/or gum elastic bougie, oral & nasal airways, surgical airway kit, drugs, C02 detector, monitors, other rescue equipment
2. **Pre-Oxygenate (Denitrogenate) the lungs (1,2,6)**
   - Prolongs tolerance of apneic period
   - Goal is ≈ 3 minutes of tidal volume breathing at 90% FiO2
   - With standard reservoir facemask set flow rate of oxygen as high as possible
   - Recommend augmenting with nasal cannula at 15L/min oxygen in preparation for apneic oxygenation, leave in situ throughout procedure (2,8)
   - Elevate head of bed if not contraindicated
3. **Maintain cervical spine stabilization**
4. **Remove front of cervical collar**
5. **Consider cricoid pressure simultaneous w/ medication administration (9,10)**
6. **Administer medications** : Initiate RSI

Sedative/hypnotic
- Ketamine (First Line): 2 mg/kg IV/IO
- Etomidate (Second Line): 0.3 mg/kg IV/IO

Unstable patients require reduced dosage of induction agent.

Neuromuscular Blockade
- Rocuronium: 1.2 mg/kg IV/IO or
- Vecuronium: 0.1 mg/kg IV/IO or
- Succinylcholine: 1.5 mg/kg IV/IO

7. **Perform laryngoscopic tracheal intubation**
   - Following onset of neuromuscular blockade
   - Recommend gum elastic bougie as primary ETT stylet
8. **If laryngoscopic view is poor:**
   - Apply external laryngeal manipulation technique(s)
   - Consider alternative visualization method or Supraglottic airway device
9. **Confirm tracheal intubation**
   - Visualize tube passing between the vocal cords (First Line)
   - Wave form or digital capnography when available (Second Line)
   - Easy chest rise, equal axillary breath sounds/absence of gastric insufflation, CO2 Calorimeter, and "fog" in ETT
   - Esophageal detector bulb or fiber optic confirmation during cardiac arrest
10. **Provide continuing care IAW Anesthesia CPG**

Recommendations for Pediatric Patients

1. Train to expect pediatric patients. Have a dedicated pediatric airway cart, including Broselow tape or equivalent.
2. Pre-dose with atropine IV/IO (0.02mg/kg, minimum dose 0.1mg, maximum dose 0.5mg) in all <1 years old, those <5 who are receiving succinylcholine, and in all who receive a 2nd dose of succinylcholine
3. Induction -
   - Ketamine (first line) 2mg/kg IV/IO
   - Etomidate (second line) 0.3mg/kg IV/IO
4. Neuromuscular blockade -
   - Succinylcholine 1.5mg/kg IV/IO (2mg/kg <5 years old) or
   - Rocuronium 1mg/kg IV/IO
5. Avoid surgical airway in <12 years old - use needle cricothyroidotomy (12-14 gauge), tracheostomy preferred over surgical cricothyroidotomy

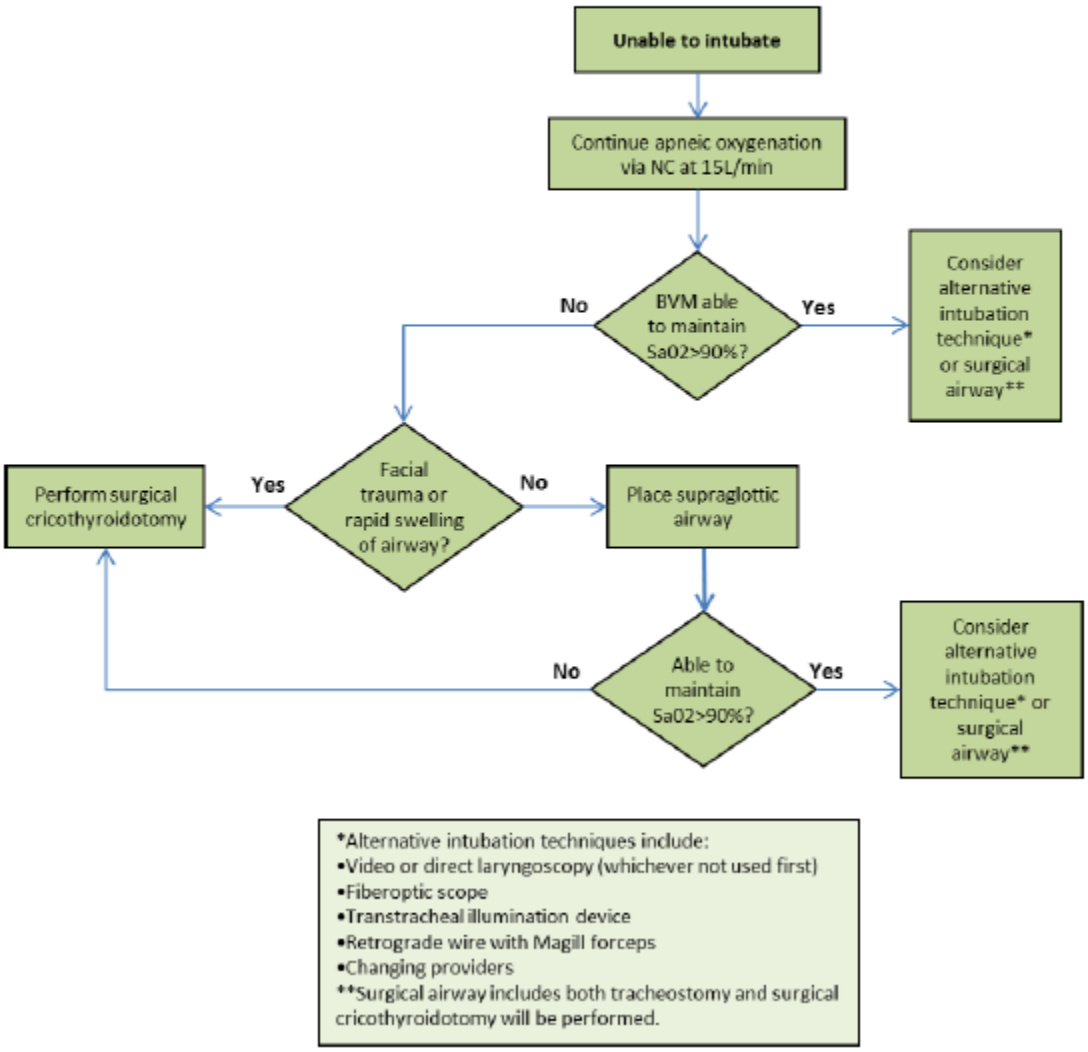
Unable to Intubate: Can You Mask Ventilate?

Mask Ventilation Pearls
- Skilled operator
- Good seal
- Jaw thrust
- Oral airway
- Nasal airway(s)
- Two operator mask ventilation

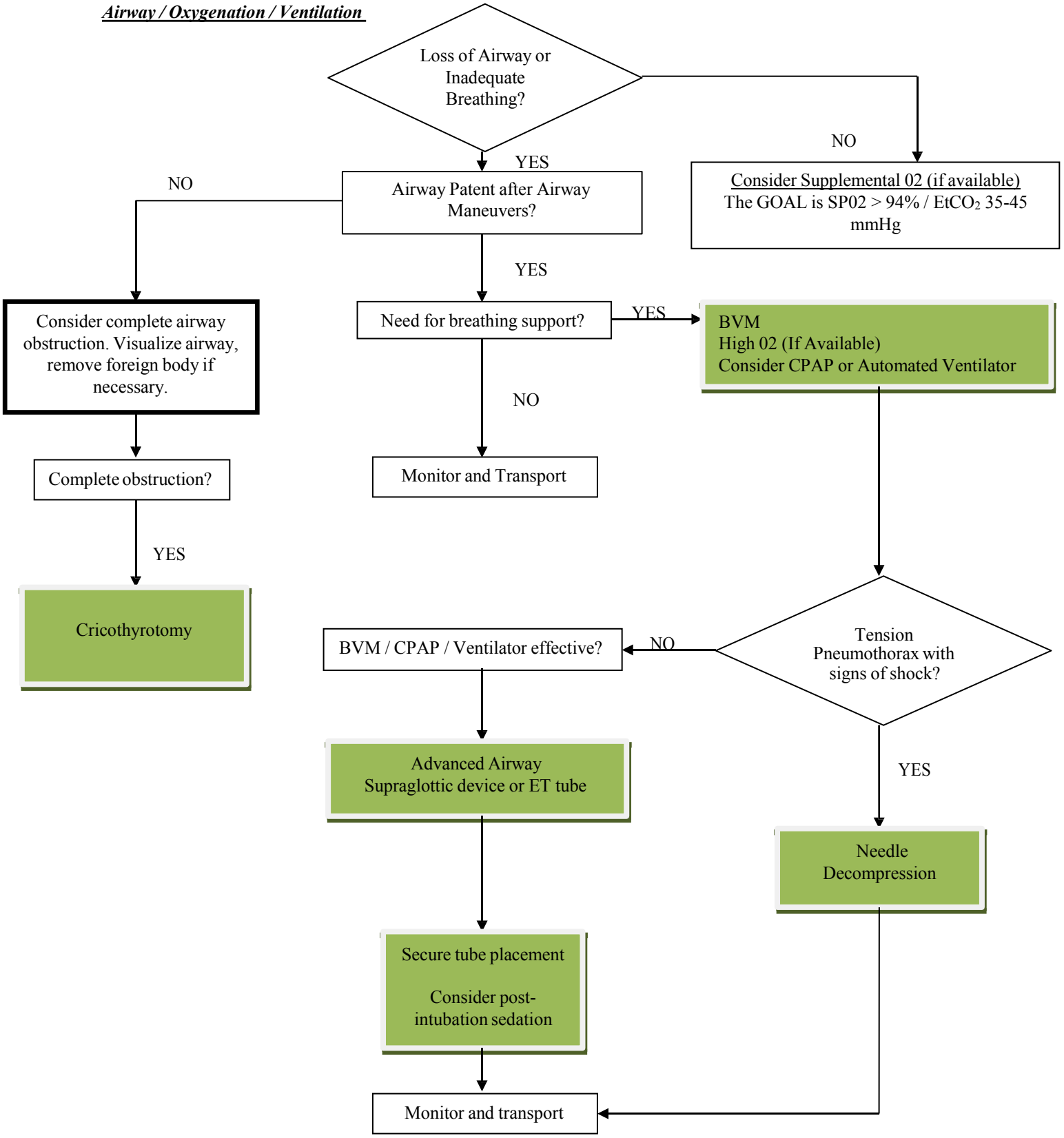
YES
- Improve position, change blade/operator, laryngeal manipulation technique, gum elastic bougie.
- Attempt alternate technique: Fiber optic, video laryngoscope, tracheal trans illumination device.
- More than ≈ 3 attempts at intubation may abolish your ability to mask ventilate due to edema caused by laryngoscopy.
- Surgical airway (Cricothyroidotomy or tracheostomy)

NO
- Emergency pathway...seconds matter.
- Supraglottic airway or
- Surgical cricothyroidotomy

APPENDIX B: DIFFICULT AIRWAY MANAGEMENT ALGORITHM


Unable to intubate
Continue apneic oxygenation via NC at 15L/min
BVM able to maintain Sa02>90%?
No
Yes
Consider alternative intubation technique* or surgical airway**
Facial trauma or rapid swelling of airway?
Yes
No
Perform surgical cricothyroidotomy
Place supraglottic airway
Able to maintain Sa02>90%?
No
Yes
Consider alternative intubation technique* or surgical airway**
*Alternative intubation techniques include:
•Video or direct laryngoscopy (whichever not used first)
•Fiberoptic scope
•Transtracheal illumination device
•Retrograde wire with Magill forceps
•Changing providers
**Surgical airway includes both tracheostomy and surgical cricothyroidotomy will be performed.

Airway / Oxygenation / Ventilation



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III. ADULT PATIENT CARE PROTOCOLS

2. ***Allergic / Anaphylactic Reaction***

A. Objectives:

1) To assess and appropriately treat patients with allergic reaction and/or anaphylaxis.

2) To differentiate between an allergic reaction and anaphylaxis.

B. General Information:

1) Rapidly progressing signs and symptoms shall be treated as anaphylaxis.

2) RS or RS-EMT's may use patients EPI-Pen or EPI-Pen from Med Kit.

3) In severe anaphylaxis with hypotension and/or severe airway obstruction, medical control may order Epinephrine 1: 10,000 IV.

4) Solu-Medrol should not be routinely administered to pediatric patients, however may be considered by medical control for extended transports.

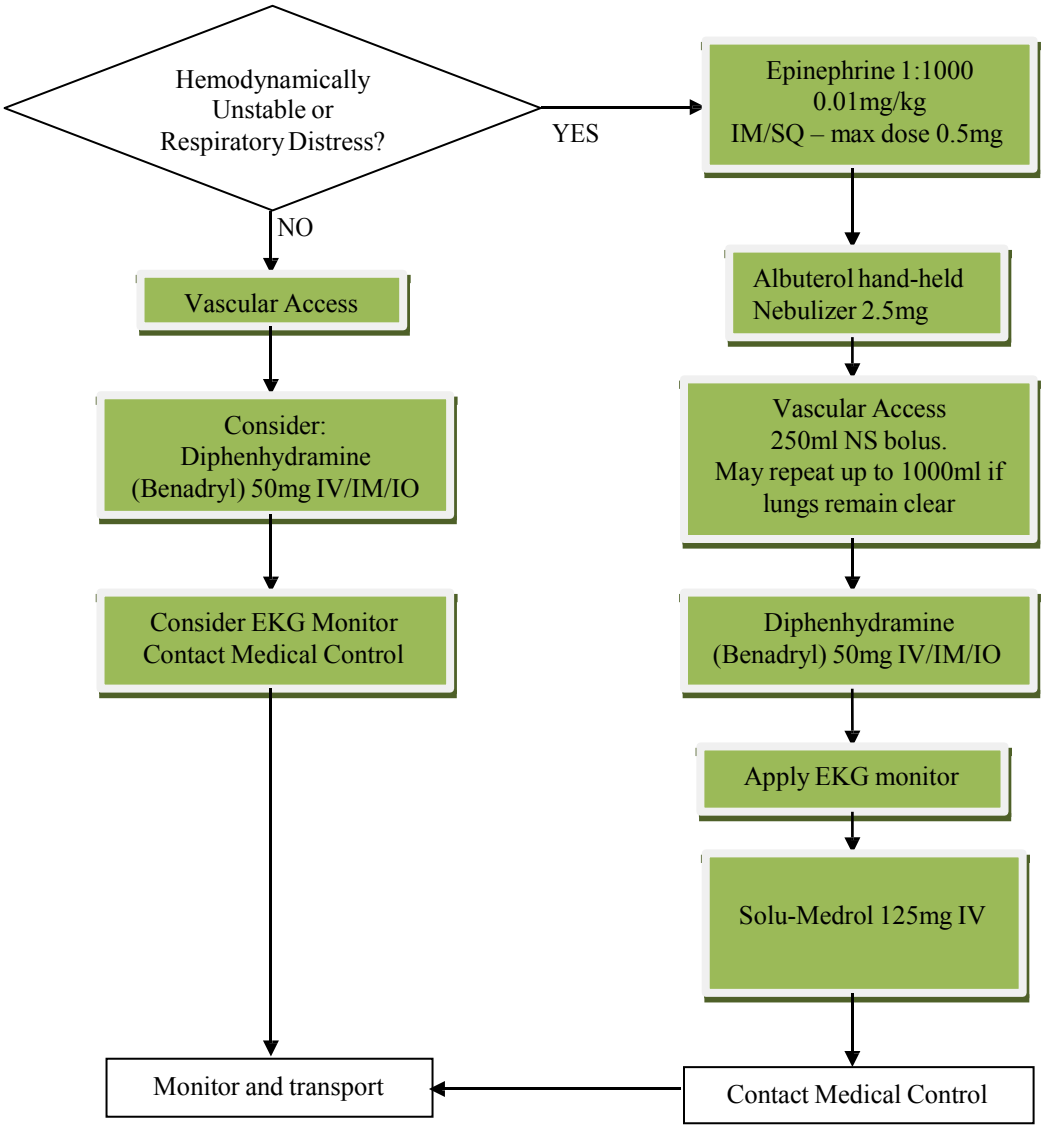
C. Warnings/Alerts:

1) Epinephrine 1:1000 shall not be given IV.

2) Contact medical control before administering Epinephrine to patients with cardiac HX or 40 years or older.

3) Maximum dose of Epinephrine 1:1000 is 0.5mg.

Allergic / Anaphylactic Reaction


Hemodynamically Unstable or Respiratory Distress?
YES
NO
Epinephrine 1:1000 0.01mg/kg IM/SQ – max dose 0.5mg
Albuterol hand-held Nebulizer 2.5mg
Vascular Access 250ml NS bolus. May repeat up to 1000ml if lungs remain clear
Diphenhydramine (Benadryl) 50mg IV/IM/IO
Apply EKG monitor
Solu-Medrol 125mg IV
Contact Medical Control
Vascular Access
Consider: Diphenhydramine (Benadryl) 50mg IV/IM/IO
Consider EKG Monitor Contact Medical Control
Monitor and transport

III. ADULT PATIENT CARE PROTOCOLS

3. Altered Mental Status / Syncope

A. Objective:

1) To appropriately assess and treat patients with Altered Mental Status / Syncope

B. General Information:

1) Consider alternate causes using AEIOU-TIPS:
- Alcohol / Acidosis
- Epilepsy
- Insulin
- Overdose
- Uremia / Renal Failure
- Trauma
- Infection
- Psychosis
- Seizures

2) Rechecking glucose after all interventions.

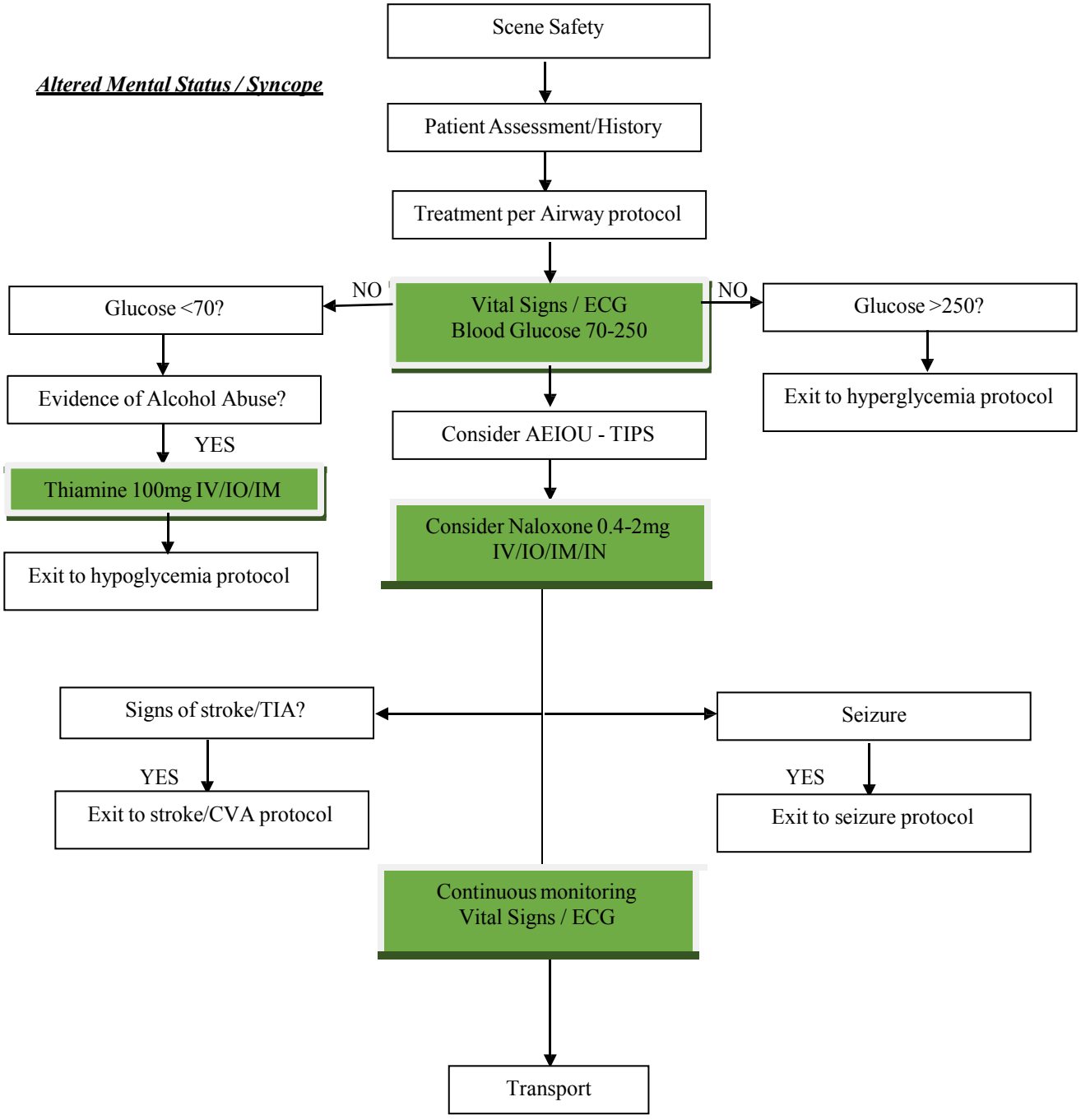
3) Assess for signs of trauma in any syncopal event.

4) EKG monitoring should be obtained in all suspected toxin or diabetic ketoacidosis events.

C. Warnings/Alerts:

1) Be aware of AMS as a presentation of environmental exposure, toxins, and hazmat. Use proper PPE and Decontamination procedures as appropriate.

Altered Mental Status / Syncope



III. ADULT PATIENT CARE PROTOCOLS

4. Altitude Medical Emergencies

D. Objective:

1) To appropriately assess and treat patients with Altitude Illness.

2) Descend to safe appropriate altitude and if symptoms do not resolve, begin treatment.

E. General Information:

1) Acute Mountain Sickness (AMS): Usually occurs at altitudes 8,000ft and higher. Symptoms can occur as quickly as 3 hours after ascent. Signs and symptoms are generally benign and self-limiting, but can become debilitating. Anorexia, nausea, vomiting, insomnia, dizziness, lassitude, and or fatigue.

2) High Altitude Pulmonary Edema (HAPE): Caused by hypoxia of altitude. HAPE is the most common cause of death at altitude. Usually occurs above 8,000ft. Respiratory distress at altitude is HAPE until proven otherwise. Hallmark sign is dyspnea at rest. Other symptoms may include cough, crackles upon auscultation, tachypnea, tachycardia, fever, or low SpO_2 sat disproportionate to elevation.

3) High Altitude Cerebral Edema (HACE): Rare below 11,500ft. Headache is common at altitude and not always associated with HACE. Ataxia and altered mental status at altitude are HACE until proven otherwise. Symptoms include unsteady, wide unbalanced gait and AMS.

F. Warnings/Alerts:

1) HAPE and HACE may coexist in the same patient. If suspected, treat both
2) HAPE and HACE should prompt emergent evacuation and descent
3) Individuals with HACE should not be left alone or allowed to descend alone
4) GAMOW Bag treatment is not a substitute for descent.
5) Minimize patient exertion during descent since this will exacerbate symptoms

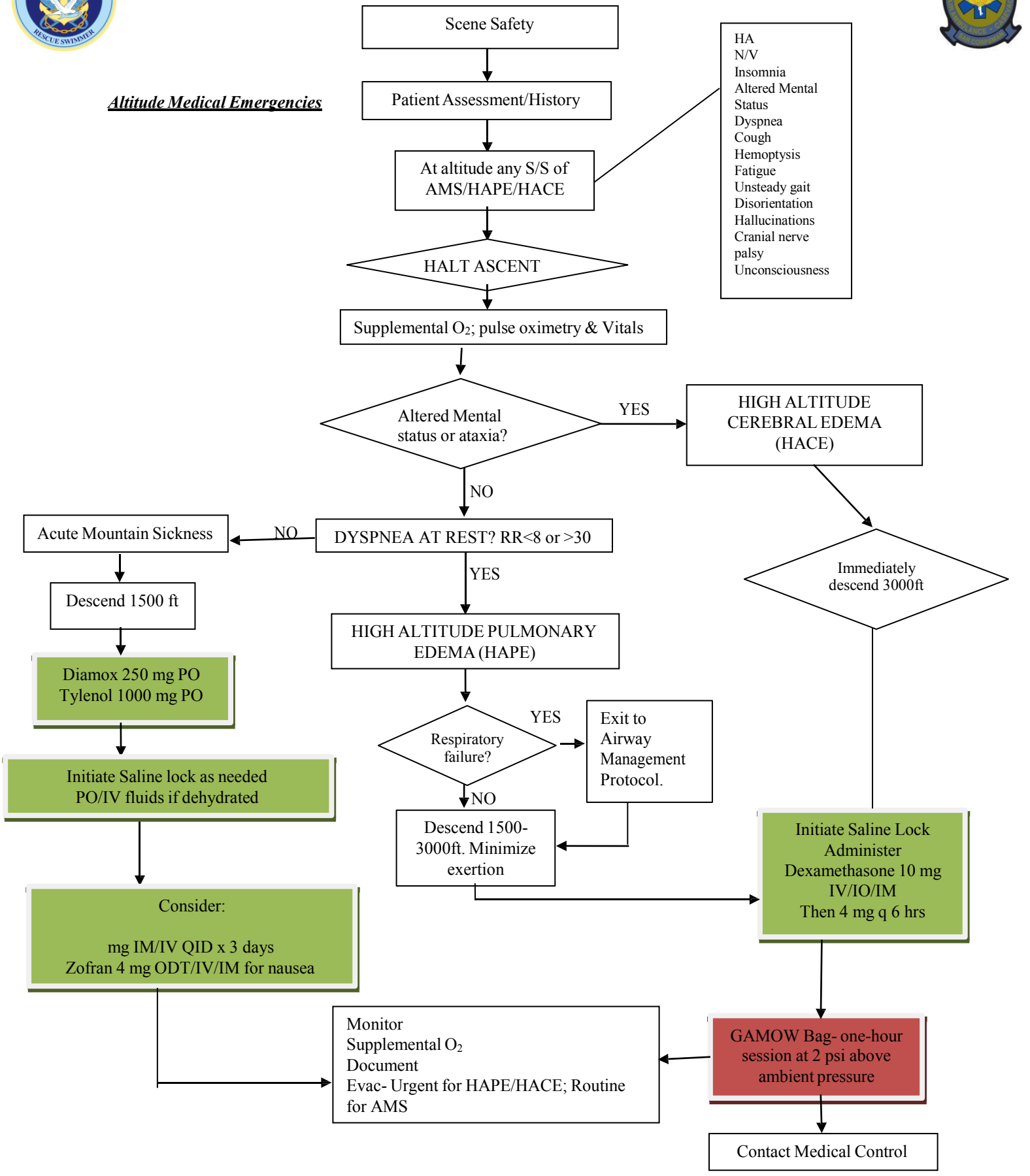
G. Medications/Treatments:

1) Diamox (Acetazolamide)- FOR AMS- 250 mg PO BID; contraindicated in patients with allergy to sulfa

2) Dexamethasone (Decadron)- FOR AMS- 4 mg PO q 6 hours (do not ascend until patient asymptomatic for 24 hours after administration); FOR HAPE/HACE- 10 mg IV/IO/IM STAT, then 4 mg IV/IO/IM q 6 hours

3) GAMOW Bag- One-hour session with bag inflated to 2 PSI above ambient pressure (approx.100 mmHg); repeat four to five times if tactically feasible

Altitude Medical Emergencies



III. ADULT PATIENT CARE PROTOCOLS

5. Bites and Stings

A. Objectives:

1) To appropriately assess and treat patients who receive bites and stings.

2) To identify source of bite and sting.

B. General Information:

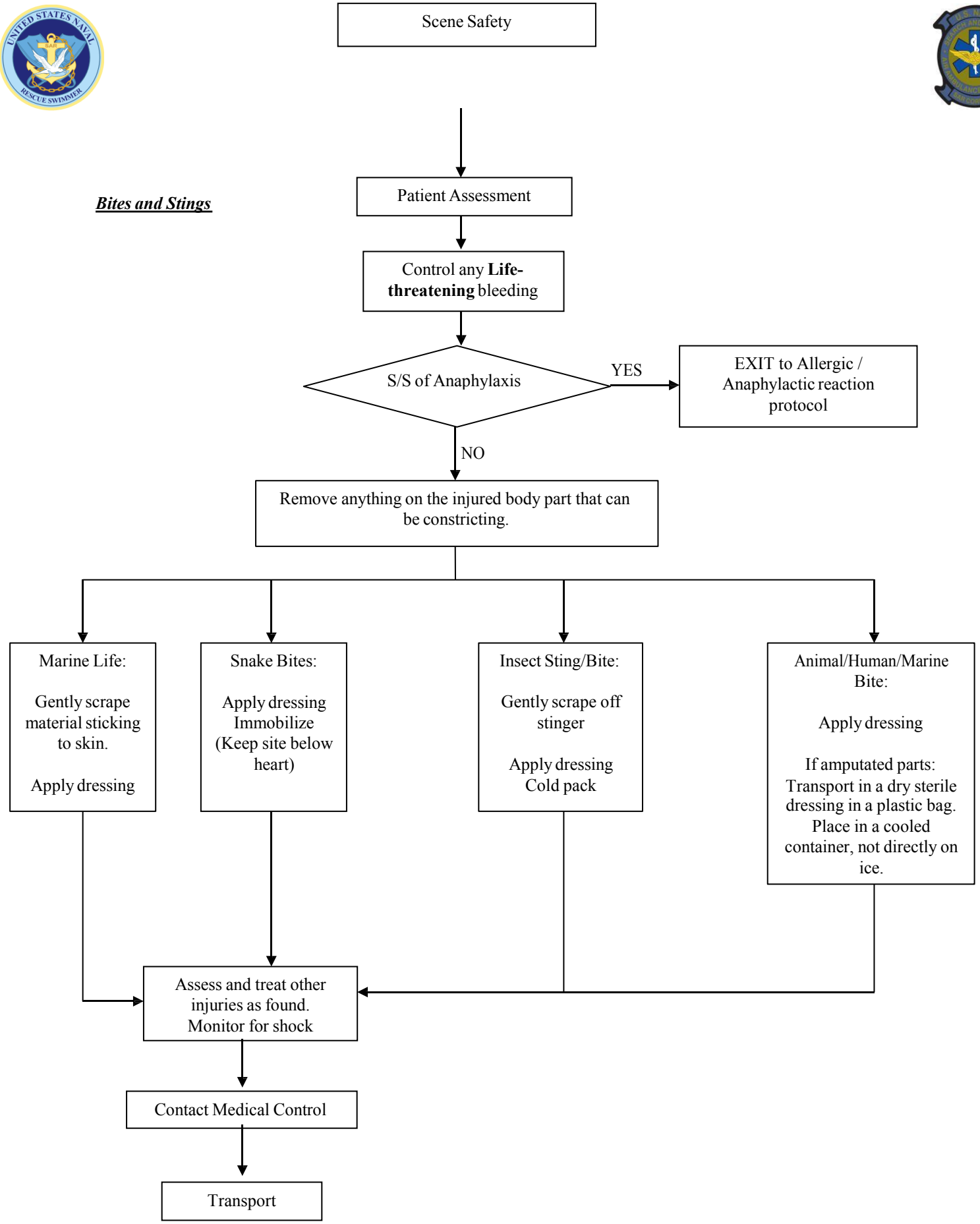
1) The use of constriction bands requires an order from Medical Control.

C. Warnings/Alerts:

1) Make no attempt to capture or kill the animal or insect that inflicted the bite or sting.

2) Shall not transport live animals in the Aircraft. Crew should consider extreme caution in transporting dead animal or consider taking picture of the animal to show Medical Control.

Bites and Stings



III. ADULT PATIENT CARE PROTOCOLS

6. Blood Component / Fresh Whole Blood Use:

A. Objectives:

1) Administration of Blood Components and Whole Blood as per JTS CPG's and DOD TCCC Protocols.

2) Calcium shall be pushed on all patients in hypovolemic shock, requiring blood products, or suspected trauma. 1gm Calcium slow IV/IO push via patent line.

IMMEDIATE CLINICAL INDICATIONS in trauma patients with SERIOUS INJURIES and evidence of hemorrhage / shock:

- Systolic blood pressure less than 100 mm Hg or absence of radial pulse
- Tachycardia greater than 100 beats per minute (BPM) or higher
- Double, triple, or quadruple amputation

CLINICAL INDICATIONS:

- Uncontrolled hemorrhage or evidence of hemorrhagic shock
  - Trauma patients with amputation (complete or partial with distal circulation compromise)
  - Non-compressible penetrating thoracic, abdominal, and transitional zone injuries (axilla, inguinal, neck)
  - Pelvic Fractures in conjunction with traumatic injury (significant mechanism of injury)
  - Clinical signs of coagulopathy
    - Tachycardia, tachypnea, fever, altered mentation, hypoxemia
  - Severe hypothermia associated with blood loss

CONTRAINIDICATIONS:

- None

PRIOR TO BLOOD PRODUCT TRANSFUSION:

- Maximal hemorrhage control
- Treatment of suspected tension pneumothorax
  - Clinical signs may include: hypotension, hypo-perfusion, diminished or absent breath sounds. Late signs include: tracheal deviation and distended neck veins.
- Patent airway or airway control
- IV/IO access
- Hypothermia prevented and/or treated

Blood Component / Fresh Whole Blood Use:

PROCEDURE:

- Document all items on the SF 518 (only authorized document for blood products aboard Army Aeromedical Evacuation platforms.
    - Two person verification of patient and blood products given matching SF 518.
- Observe units of blood
    - Look for gas, discoloration, clots, and sediment
    - Safe-T-Vue must remain white on color indicator. Red coloration indicates that temperature has been exceeded and is no longer acceptable for use.
- Initiate large bore IV (18G min, 14G preferred) or IO access.
    - IO access via sternum or humerus is preferred. Tibia site can be utilized as secondary, but attempt should be made to gain another access point.
    - Lidocaine 2% (2-3 mL) flush in IO sites provides analgesia and increases compliance.
- All blood and blood products will be administered through a dedicated line of NS using Y-tubing with filter.
- Transfuse blood through an approved fluid warming device if available.
- Rapid transfusion can be achieved by using an approved pressure infusion device.
    - Inflate pressure bag to at least 300 mmHg
    - 60 ml syringe or manual pressure can also be utilized in the event a pressure infuser is not available.
- Slow all other concurrent infusions unless they are TXA or RFVIIa.
- Continue resuscitation until palpable radial pulse, improved mental status or SBP of 70-80 mmHg and MAP >60 mmHg.
- Monitor patient every 5 minutes and document any patient signs and symptoms consistent with a transfusion reaction. These include: chills, back or chest pain, rash, fever, hives and/ or wheezing.

Document procedure, results, and vital signs of the SF 518.

CLINICAL PEARLS AND CONSIDERATIONS:

- Febrile Reaction- Temperature increase (1°C or 2°F) from baseline, chills, flushing, headache and rapid pulse
- Allergic/Anaphylaxis Reaction- itching, chills, flushing, nausea/vomiting, coughing and/or wheezing, or laryngeal edema
    - Treat with Diphenhydramine 50mg IVP or IM. Have epinephrine standing by.
- Acute Hemolytic Reaction- rapid onset of dyspnea, hypotension, hemoglobinuria, rise in venous pressure, distended neck veins, cough and/or crackles at the bases of

Blood Component / Fresh Whole Blood Use:

the lungs. Treatment is to stop the transfusion, titrate O2 saturations above 94%, and increase IV fluid hydration to 100-200mL/hr to support a urine output above 100-200mL/hr.

- Circulatory Overload- onset of shortness of breath, tachycardia, hypertension, jugular vein distention, pulmonary rates, and hypoxia. This condition may be difficult to distinguish from a hemolytic reaction.
- If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to restore and maintain a normal radial pulse. If BP monitoring is available, maintain a target systolic BP of at least 70 mmHg.

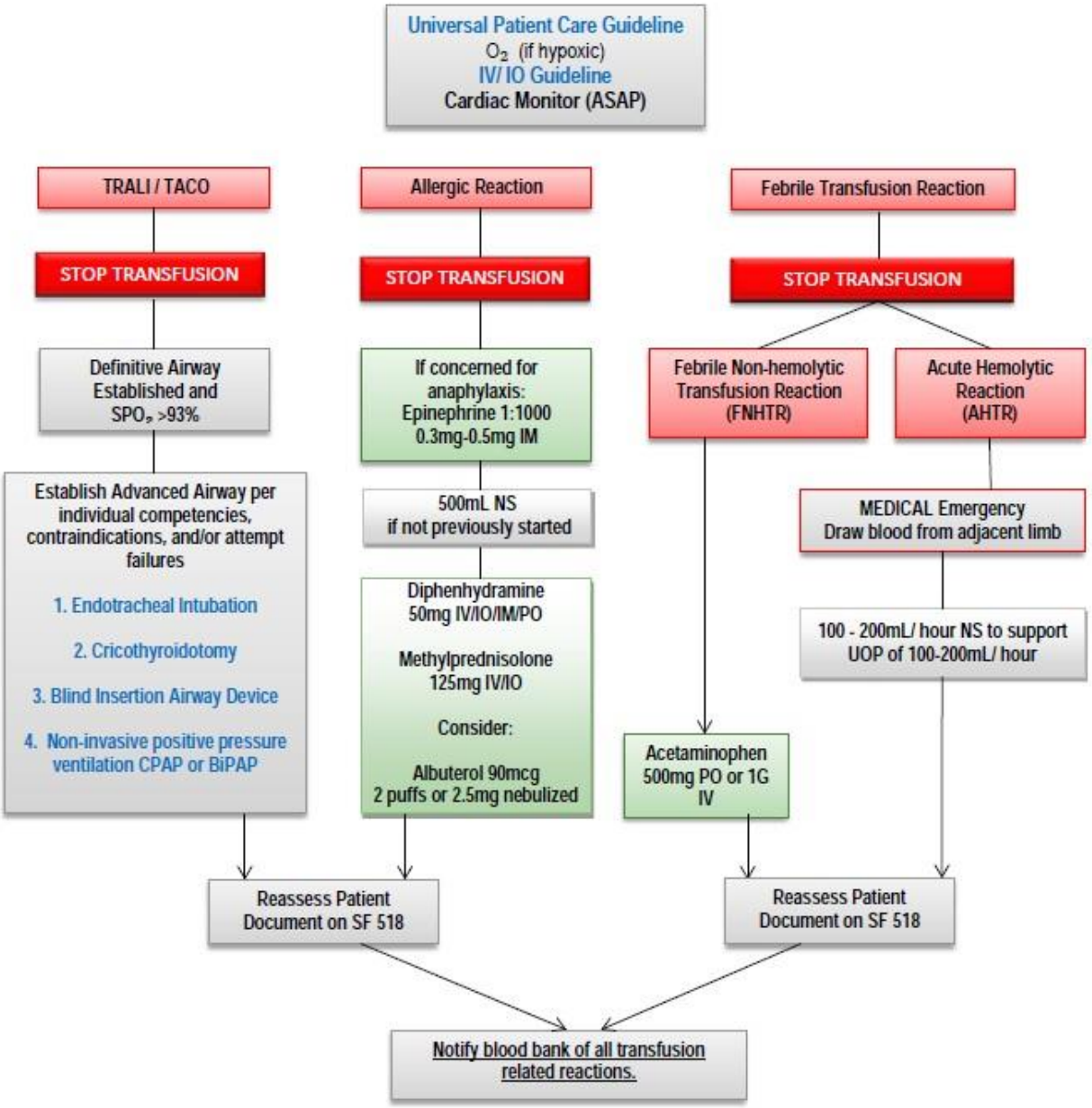
*** Blood component therapy is location specific and is not standard for all missions OCONUS and CONUS. Whole Blood not FDA approved will not be utilized on MEDEVAC air craft unless otherwise specified by area policy or Joint/Army Blood Program.

Differential Diagnosis:	Signs and Symptoms:
Febrile non-hemolytic transfusion reaction (FNHTR)	Fever (>100.4°F) increase of 1°C or 2°F from baseline, chills, possible dyspnea
Acute hemolytic transfusion reaction (AHTR)	Fever (>100.4°F), chills, flank pain, red/brown urine
Anaphylaxis reaction	Rapid onset of shock, hypotension (<100mmHg systolic), angioedema, and respiratory distress
Transfusion-transmitted bacterial infection	Fever (>102.2°F or >3.6°F change after transfusion), rigors, tachycardia (>120 bpm or >40 bpm following transfusion), rise or fall of systolic blood pressure (>30mmHg)
Mechanical-caused hemolysis	Varies with each device. Fever (>100.4°F), chills, possible dyspnea
Transfusional volume/circulatory overload (TACO)	Dyspnea, orthopnea, tachycardia (>100 bpm), wide pulse pressure, hypertension (>140mmHg systolic), hypoxemia (SPO2 <94%), headache, possible seizure
Transfusion-related acute lung injury (TRALI)	Hypoxemia (SPO2 <94%), Fever (>100.4°F), hypotension (<100mmHg systolic), cyanosis, tachypnea (>24 breaths per minute), tachycardia (>100 bpm)

Pearls:

- GENERAL RULES:
  - Stop the transfusion
  - Keep the intravenous line open with saline
  - Identify and treat cause of the reaction
  - Re-institute the transfusion only if it is deemed to be clinically essential
- Before initiating IVF bolus, ensure IV tubing is new. DO NOT USE existing Y-tubing from blood administration set.
- The most common transfusion reaction is a febrile, non-hemolytic transfusion reaction. These are mostly benign with no lasting sequelae. Treatment consists of antipyretics. (Acetaminophen 500mg PO every 4 hours or 1 Gram IV every 6 hours.)
- TRALI is the leading cause of transfusion-related mortality and commonly occurs is patients who have undergone recent surgery, massive blood transfusion, or who have an active infection. Goal of treatment is supportive and aimed at maintaining oxygenation and reducing respiratory distress.
- TACO is essentially pulmonary edema secondary to congestive heart failure usually occurring in elderly, small children and those with compromised cardiac function. Large volumes of fluid given rapidly are a common precursor to this reaction. Goal is aimed at mobilizing fluids (diuretics) and treating underlying condition. Both TACO and TRALI require immediate resuscitation by an advanced level practitioner.
  - A unit of packed cells should be given at a rate of 2.5-3.0 mL/kg per hour.
- Mechanical-caused hemolysis is commonly caused by rapid transfusion, poor collection and storage, or heating the blood above 42°C during transfusion.

Blood Component / Fresh Whole Blood Use:


Universal Patient Care Guideline
O_2 (if hypoxic)
IV/ IO Guideline
Cardiac Monitor (ASAP)
TRALI / TACO
STOP TRANSFUSION
Definitive Airway Established and SPO_2 >93%
Establish Advanced Airway per individual competencies, contraindications, and/or attempt failures
1. Endotracheal Intubation
2. Cricothyroidotomy
3. Blind Insertion Airway Device
4. Non-invasive positive pressure ventilation CPAP or BiPAP
Allergic Reaction
STOP TRANSFUSION
If concerned for anaphylaxis: Epinephrine 1:1000 0.3mg-0.5mg IM
500mL NS if not previously started
Diphenhydramine 50mg IV/IO/IM/PO
Methylprednisolone 125mg IV/IO
Consider:
Albuterol 90mcg 2 puffs or 2.5mg nebulized
Febrile Transfusion Reaction
STOP TRANSFUSION
Febrile Non-hemolytic Transfusion Reaction (FNHTR)
Acetaminophen 500mg PO or 1G IV
Acute Hemolytic Reaction (AHTR)
MEDICAL Emergency Draw blood from adjacent limb
100 - 200mL/ hour NS to support UOP of 100-200mL/ hour
Reassess Patient Document on SF 518
Reassess Patient Document on SF 518
Notify blood bank of all transfusion related reactions.

Pearls:

- Blood transfusions conducted during point of injury for casualties suffering from blood loss/massive hemorrhage may not show any transfusion reaction during the limited transport time.

III. ADULT PATIENT CARE PROTOCOLS

7. *Breathing Difficulty:*

A. Objectives:

1) To assess and treat patients with breathing difficulty.

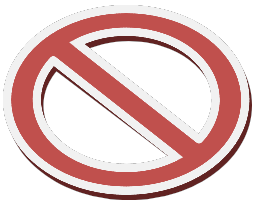
2) To determine the most likely cause of the patients breathing difficulty.

B. General Information:

1) A patient with a HX of CHF that has wheezing upon auscultation of lung sounds should not be automatically classified as asthma / COPD patient.

2) Congestive Heart Failure (CHF) is primarily a cardiac event, not a respiratory event. Treatment should be focused on reducing preload and after load. CPAP or aggressive BVM treatment is an appropriate first line treatment. Patients in end stage renal failure should get Medical Control orders before the administration of Lasix.

3) Bronchoconstriction (Asthma, COPD) patients in severe distress may receive Albuterol 2.5mg/ Atrovent 0.5mg duo Nebulizer as first line treatment. Atrovent shall only be used once.
For severe asthma Medical control may order:
- Epinephrine 1:1,000 0.01mg/kg IM, max dose of 0.5mg



C. Warnings/Alerts:

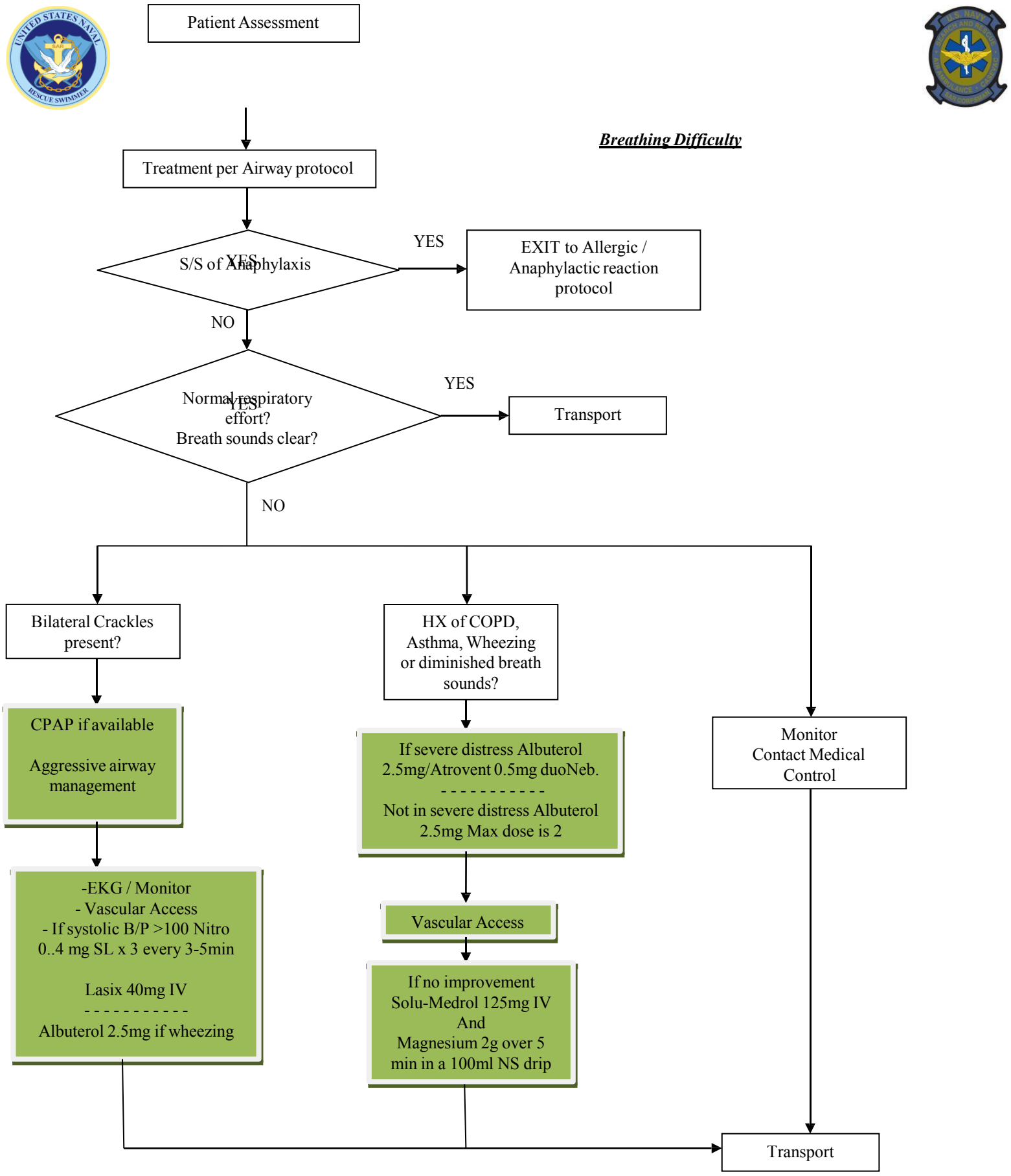
1) Do not administer Epinephrine 1:1,000 IV/IO

2) Do not administer Nitroglycerin to patients that have taken PDE inhibitors in the past 72 hours.

3) CPAP may worsen existing hypotension.

4) Patients must be conscious with regular respirations for CPAP to be effective.

5) Consider spontaneous pneumothorax vs. tension, monitor closely for s/s of shock.


Patient Assessment
Breathing Difficulty
Treatment per Airway protocol
S/S of Anaphylaxis
YES
YES
EXIT to Allergic / Anaphylactic reaction protocol
NO
Normal respiratory effort?
Breath sounds clear?
YES
YES
Transport
NO
Bilateral Crackles present?
HX of COPD, Asthma, Wheezing or diminished breath sounds?
Monitor
Contact Medical Control
CPAP if available
Aggressive airway management
If severe distress Albuterol 2.5mg/Atrovent 0.5mg duoNeb.
- - - - - - - - - - -
Not in severe distress Albuterol 2.5mg Max dose is 2
-EKG / Monitor
- Vascular Access
- If systolic B/P >100 Nitro 0..4 mg SL x 3 every 3-5min
Lasix 40mg IV
- - - - - - - - - - -
Albuterol 2.5mg if wheezing
Vascular Access
If no improvement
Solu-Medrol 125mg IV
And
Magnesium 2g over 5 min in a 100ml NS drip
Transport

III. ADULT PATIENT CARE PROTOCOLS

8. ***Burns***

A. Objectives:

1) To assess and appropriately treat patients with burn injuries.

2) To determine the extent and severity of burn injuries.

B. General Information:

1) Stop the burning process.

2) Remove affected clothing, if clothing is stuck to skin cut the clothing instead of pulling it away.

3) Burned areas shall be covered with dry sterile dressings.

4) Parkland formula for IV Fluid Replacement

$$\underline{2ml \times BSAB \times weight = total\ fluid\ in\ ml}$$

Give this amount over first 8 hrs from time of injury, then equal amount over the next 16 hours

5) Urinary Output is the MOST reliable guide in predicting adequate resuscitation:
Adult: 0.5ml per kg per hour (100ml/hr for Electrical Burns)
Children: <40kg: 1ml/kg/hr

C. Warnings/Alerts:

1) Do not delay transport to start IV's or perform other non-life saving ALS interventions.

2) In mass casualty situations from Lighting Strikes, reverse triage should be performed (I.E. those in cardiac arrest should be resuscitated first). Ventricular fibrillation and asystole are the most common dysrhythmias.

3) Inhalation burns with impending airway compromise should be treated with aggressive airway management. Burns with >40%, will likely require RSI due to airway edema from inflammation/fluid resuscitation.

4) Burn patients are prone to hypothermia and shall be protected from the environment. Avoid using ice to cool "large" affected areas.

5) Never use nitrates for suspected Cyanide toxicity in enclosed space fires, it can worsen hypoxia. If a suspected cyanide toxicity, consider use of hydroxcobalmin (CYANOKIT)

Burns

Patient Assessment

↓

Treatment per Airway protocol

↓

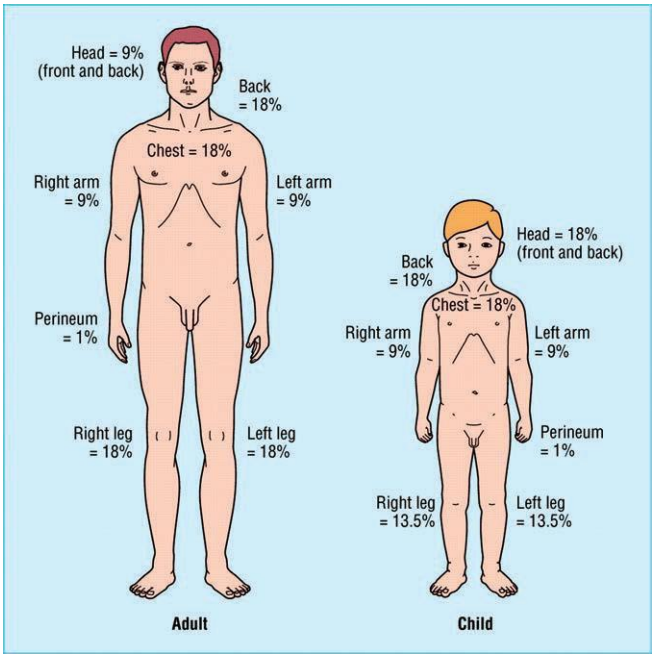
Stop the burning process

↓

Consider aggressive airway management for inhalation injury

↓

Estimate body surface burned



↓

Monitor
Prevent and
Treat for Hypothermia

↔

All Electric burns or possible electrocutions require EKG Monitoring.

↓

Vascular Access
2ml X BSAB x weight = total fluid in ml

↓

Pain medications per Pain Protocols

↔

Transport to burn center or Level 1 trauma center as appropriate.

III. ADULT PATIENT CARE PROTOCOLS

9. *Cerebral Vascular Accident*

A. Objectives:

1) To assess and appropriately treat patients with suspected CVA or Stroke.

B) General Information:

1) Obtain specific history:
- Onset of stroke symptoms
- List of signs/symptoms
- Previous CVA?
- New onset dysrhythmias

2) From time of first signs and symptoms to advance level of care, timeline of transport should be under 90 minutes.

3) Cincinnati Prehospital Stroke Scale is preferred method of prehospital determination. In the event that the assessment of the patient is done in the aircraft, the Los Angeles Pre-Hospital Stroke Screen (LAPSS) should be done.

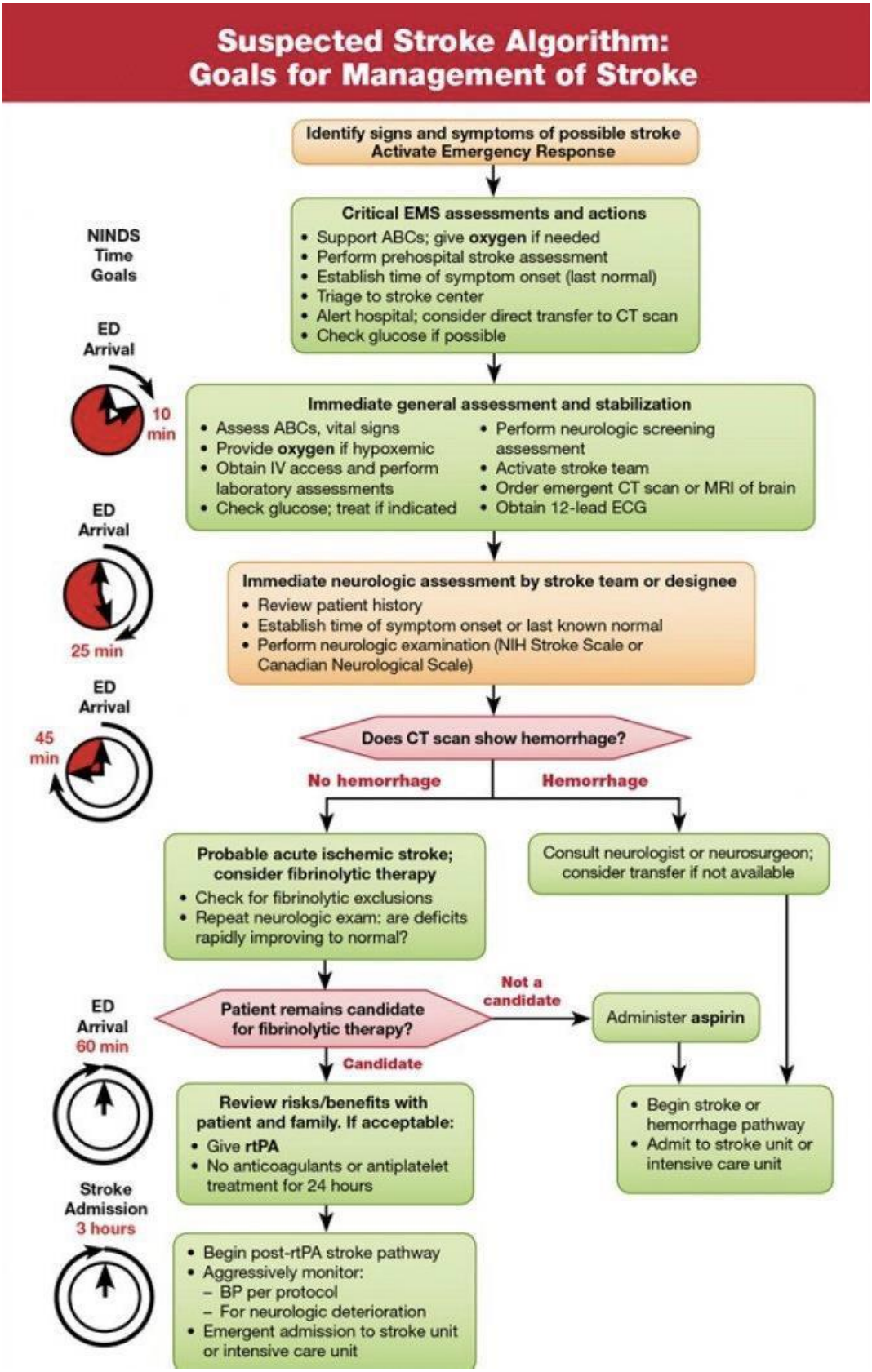
4) Using the Cincinnati Scale, if any of the screening questions are answered yes and the exam is positive for any one Stroke signs and symptoms then the patient should be treated as a Cerebral Vascular Accident. Information shall be relayed to the appropriate next level of care to relay the Cincinnati Stroke Scale results.

C. Warnings/Alerts:

1) Do not delay transport to start IV's or perform other non-life-saving ALS interventions.

2) Patients with stroke symptoms are at high risk for airway compromise.

3) Hypoxemia will worsen stroke outcomes.


Suspected Stroke Algorithm:
Goals for Management of Stroke
Identify signs and symptoms of possible stroke
Activate Emergency Response
NINDS Time Goals
Critical EMS assessments and actions
• Support ABCs; give oxygen if needed
• Perform prehospital stroke assessment
• Establish time of symptom onset (last normal)
• Triage to stroke center
• Alert hospital; consider direct transfer to CT scan
• Check glucose if possible
ED Arrival
10 min
Immediate general assessment and stabilization
• Assess ABCs, vital signs
• Provide oxygen if hypoxemic
• Obtain IV access and perform laboratory assessments
• Check glucose; treat if indicated
• Perform neurologic screening assessment
• Activate stroke team
• Order emergent CT scan or MRI of brain
• Obtain 12-lead ECG
ED Arrival
25 min
Immediate neurologic assessment by stroke team or designee
• Review patient history
• Establish time of symptom onset or last known normal
• Perform neurologic examination (NIH Stroke Scale or Canadian Neurological Scale)
ED Arrival
45 min
Does CT scan show hemorrhage?
No hemorrhage
Hemorrhage
Probable acute ischemic stroke; consider fibrinolytic therapy
• Check for fibrinolytic exclusions
• Repeat neurologic exam: are deficits rapidly improving to normal?
Consult neurologist or neurosurgeon; consider transfer if not available
ED Arrival 60 min
Patient remains candidate for fibrinolytic therapy?
Not a candidate
Administer aspirin
Candidate
Review risks/benefits with patient and family. If acceptable:
• Give rtPA
• No anticoagulants or antiplatelet treatment for 24 hours
• Begin stroke or hemorrhage pathway
• Admit to stroke unit or intensive care unit
Stroke Admission 3 hours
• Begin post-rtPA stroke pathway
• Aggressively monitor:
– BP per protocol
– For neurologic deterioration
• Emergent admission to stroke unit or intensive care unit

Out-of-Hospital Assessment of the Patient With Acute Stroke

- Ensure adequate airway
- Measure vital signs frequently
- Conduct general medical/trauma assessment
  - Trauma of head or neck
  - Cardiovascular abnormalities
  - Check pupils
  - Check glucose level
- Conduct neurologic examination
  - Level of consciousness
  - Cincinnati Prehospital Stroke Scale (+/–)
  - Los Angeles Prehospital Stroke Screen (+/–)
  - Glasgow Coma Scale (score/15)
  - Report right and left limb movements
  - Report meningeal signs (yes/no)
  - Report time of onset of symptoms
  - Report any seizure activity
  - Provide prearrival notification to receiving hospital of potential stroke patient

Glasgow Coma Scale

	Score (maximum = 15)
Eye opening	
Spontaneous	4
In response to speech	3
In response to pain	2
None	1
Best verbal response	
Oriented conversation	5
Confused conversation	4
Inappropriate words	3
Incomprehensible sounds	2
None	1
Best motor response	
Obeys	6
Localizes	5
Withdraws	4
Abnormal flexion	3
Abnormal extension	2
None	1

Interpretation:
Score 14 to 15: Mild dysfunction
Score 11 to 13: Moderate to severe dysfunction
Score 10: Severe dysfunction

The Cincinnati Prehospital Stroke Scale

(Kothari R, et al. *Acad Emerg Med*. 1997;4:986-990.)

Facial Droop (have the patient show teeth or smile):
- Normal—both sides of face move equally
- Abnormal—one side of face does not move as well as the other side

Arm Drift (patient closes eyes and extends both arms straight out, with palms up, for 10 seconds):
- Normal—both arms move the same *or* both arms do not move at all (other findings, such as pronator drift, may be helpful)
- Abnormal—one arm does not move *or* one arm drifts down compared with the other

Abnormal Speech (have the patient say "you can't teach an old dog new tricks"):
- Normal—patient uses correct words with no slurring
- Abnormal—patient slurs words, uses the wrong words, *or* is unable to speak

Interpretation: If any *1* of these 3 signs is abnormal, the probability of a stroke is 72%.

Left: normal. Right: stroke patient with facial droop (right side of face).

Los Angeles Prehospital Stroke Screen (LAPSS)

For *evaluation of acute, noncomatose, nontraumatic neurologic complaint*. If items 1 through 6 are ***all* checked "Yes"** (or "Unknown"), provide prearrival notification to hospital of potential stroke patient. If any item is checked "No," return to appropriate treatment protocol. *Interpretation:* 93% of patients with stroke will have a positive LAPSS score (sensitivity = 93%), and 97% of those with a positive LAPSS score will have a stroke (specificity = 97%). Note that the patient may still be experiencing a stroke if LAPSS criteria are not met.

Criteria	Yes	Unknown	No
1. Age >45 years	❑	❑	❑
2. History of seizures or epilepsy **absent**	❑	❑	❑
3. Symptom duration <24 hours	❑	❑	❑
4. At baseline, patient is **not** wheelchair bound or bedridden	❑	❑	❑
5. Blood glucose between 60 and 400	❑	❑	❑

6. ***Obvious asymmetry*** (right vs left) in ***any*** of the following 3 exam categories **(must be unilateral):**

	Equal	R Weak	L Weak
Facial smile/grimace	❑	❑ Droop	❑ Droop
Grip	❑	❑ Weak grip	❑ Weak grip
		❑ No grip	❑ No grip
Arm strength	❑	❑ Drifts down	❑ Drifts down
		❑ Falls rapidly	❑ Falls rapidly

Kidwell CS, Saver JL, Schubert GB, Eckstein M, Starkman S. Design and retrospective analysis of the Los Angeles prehospital stroke screen (LAPSS). *Prehosp Emerg Care*. 1998;2:267-273.

Kidwell CS, Starkman S, Eckstein M, Weems K, Saver JL. Identifying stroke in the field: prospective validation of the Los Angeles Prehospital Stroke Screen (LAPSS). *Stroke*. 2000;31:71-76.

One-sided motor weakness (right arm).

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III. ADULT PATIENT CARE PROTOCOLS

10. *Chemical Exposure*

A. Objectives:

1) To assess and treat patients who have been poisoned by various substances.

B. General Information:

1) If the scene is unsafe, do not put your aircraft in an unsafe environment.

2) Dry chemicals shall be brushed off before flushing the skin or eyes with water.

3) Chemical exposure to eyes can be flushed with IV saline.

4) Removed all contaminated clothing.

5) Asphyxiants:
- Examples – Carbon monoxide, cyanide, hydrogen sulfide
- Pulse oximetry may be unreliable due to effect on red blood cells

Cholinergic:
- Examples – Organophosphates, carbamates, military nerve agents

SLUDGE – Salvation, Lacrimation, Urination, Defecation, Gastro cramping, Emesis

Corrosives:
- Examples – Acids and Bases

Do not induce vomiting. Consider aggressive airway management because of mucous membrane swelling.

Hydrocarbons:
- Examples – Gasoline, methane, toluene

Do not induce vomiting.

Irritant Gas:
- Examples – Chlorine, ammonia, phosgene

Aggressive airway management per protocol.

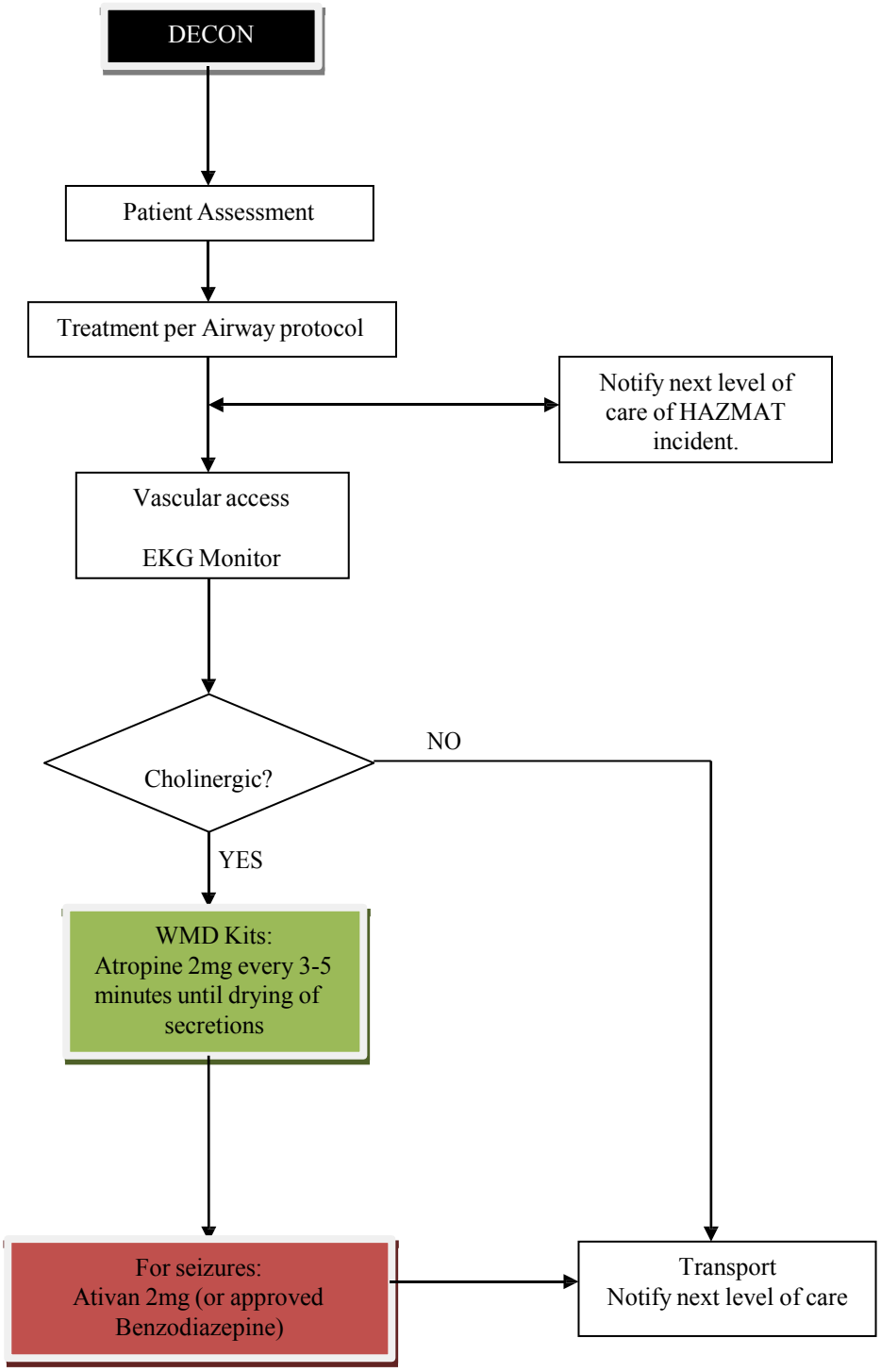
C. Warnings/Alerts:

1) Do not bring any hazardous material in the aircraft.

2) Do not use diuretics or nitroglycerin for patients with non-cardiogenic pulmonary edema.

3) PPE for the crew/providers is paramount when treating any suspected chemical exposure.

Chemical Exposure



III. ADULT PATIENT CARE PROTOCOLS

11. ***Chest Pain / AMI / ACS***

A. Objectives:

1) To assess and appropriately treat patients with chest pain or suspected AMI.

2) To eliminate patient's chest pain.

B. General Information:

1) Do not administer Aspirin in the following cases:
- HX of GI bleeding or bleeding disorders.
- HX of recent surgery
- Already taken max dose of Aspirin (324mg)
- Sensitivity / Allergy to aspirin

2) Nitroglycerin should be given to patients without IV/IO access only if blood pressure is > 100 mmHg.

3) Morphine may be administered concurrently with nitroglycerin.

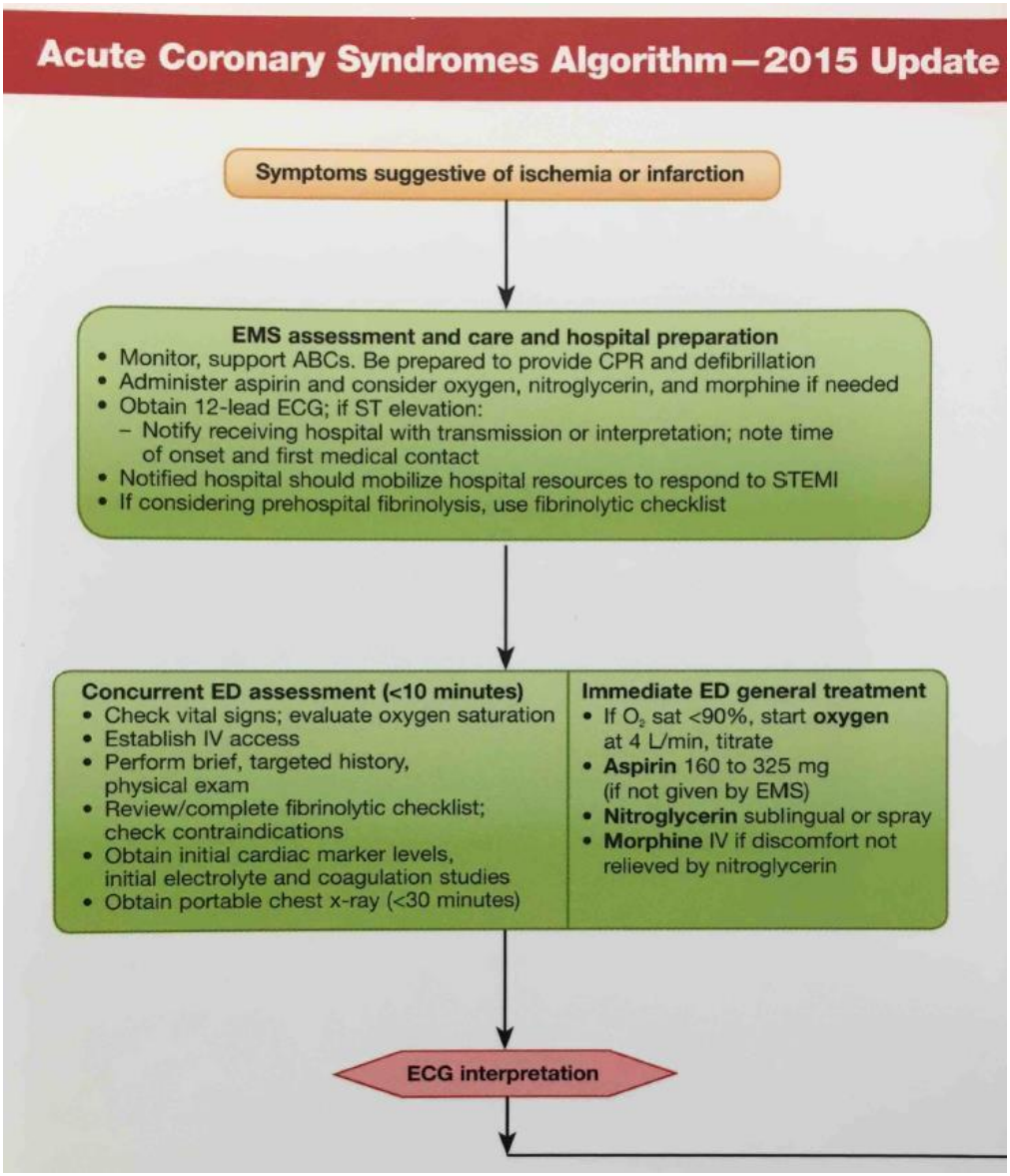
4) If the patient has cocaine-induced chest pain, Valium 5mg IV/IM may be given at discretion of Medical Control.

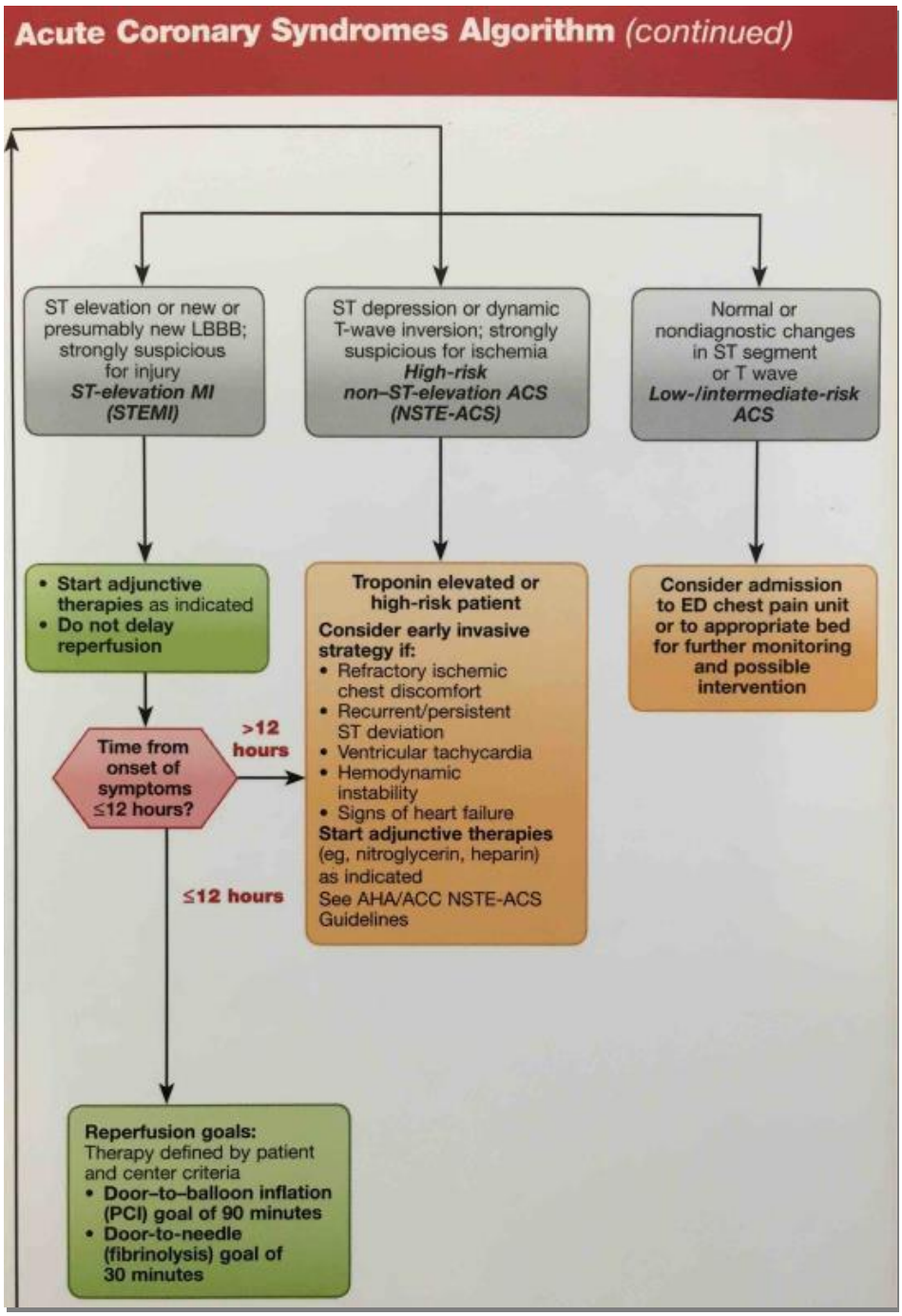
5) Do not delay patient treatment to obtain 12 Lead EKG.

C. Warnings/Alerts:

1) Do not administer nitroglycerin to patients that have taken PDE inhibitors in the past 72 hours.

2) Do not administer more than three nitroglycerin doses in a 15-minute time period.


Acute Coronary Syndromes Algorithm—2015 Update
Symptoms suggestive of ischemia or infarction
EMS assessment and care and hospital preparation
• Monitor, support ABCs. Be prepared to provide CPR and defibrillation
• Administer aspirin and consider oxygen, nitroglycerin, and morphine if needed
• Obtain 12-lead ECG; if ST elevation:
– Notify receiving hospital with transmission or interpretation; note time of onset and first medical contact
• Notified hospital should mobilize hospital resources to respond to STEMI
• If considering prehospital fibrinolysis, use fibrinolytic checklist
Concurrent ED assessment (<10 minutes)
• Check vital signs; evaluate oxygen saturation
• Establish IV access
• Perform brief, targeted history, physical exam
• Review/complete fibrinolytic checklist; check contraindications
• Obtain initial cardiac marker levels, initial electrolyte and coagulation studies
• Obtain portable chest x-ray (<30 minutes)
Immediate ED general treatment
• If O_2 sat <90%, start **oxygen** at 4 L/min, titrate
• **Aspirin** 160 to 325 mg (if not given by EMS)
• **Nitroglycerin** sublingual or spray
• **Morphine** IV if discomfort not relieved by nitroglycerin
ECG interpretation


Acute Coronary Syndromes Algorithm (continued)
ST elevation or new or presumably new LBBB; strongly suspicious for injury
ST-elevation MI (STEMI)
ST depression or dynamic T-wave inversion; strongly suspicious for ischemia
High-risk non–ST-elevation ACS (NSTE-ACS)
Normal or nondiagnostic changes in ST segment or T wave
Low-/intermediate-risk ACS
• Start adjunctive therapies as indicated
• Do not delay reperfusion
Time from onset of symptoms ≤12 hours?
>12 hours
≤12 hours
Troponin elevated or high-risk patient
Consider early invasive strategy if:
• Refractory ischemic chest discomfort
• Recurrent/persistent ST deviation
• Ventricular tachycardia
• Hemodynamic instability
• Signs of heart failure
Start adjunctive therapies (eg, nitroglycerin, heparin) as indicated
See AHA/ACC NSTE-ACS Guidelines
Consider admission to ED chest pain unit or to appropriate bed for further monitoring and possible intervention
Reperfusion goals:
Therapy defined by patient and center criteria
• Door–to–balloon inflation (PCI) goal of 90 minutes
• Door-to-needle (fibrinolysis) goal of 30 minutes

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III. ADULT PATIENT CARE PROTOCOLS

12. *Combative Patient*

A. Objectives:

1) To assess and appropriately treat a patient who is combative.

2) To ensure patient safety and safety for Aircrew.

B. General Information:

1) All patients shall be disarmed by ground medics before transport to aircraft.

2) Physical Restraint Guidelines:
- Soft restraints may be sufficient
- If Law enforcement is available, use their restraints under their supervision
- Do not endanger yourself, crew, or aircraft
- Flex cuffs, zip ties, or tie downs are authorized for in-flight environment restraints

3) Avoid placing restraints in such a way as to preclude evaluation of the patient or will cause further harm.

4) Chemical Restraint Guidelines:
- Sedative agents may be used to provide safe, humane method of restraining the violently combative patient. Ativan 2mg IM or Ketamine 2-4mg/kg
- Consider 50mg IV/IM diphenhydramine (Benadryl) if patient exhibits signs of dystonic reaction.

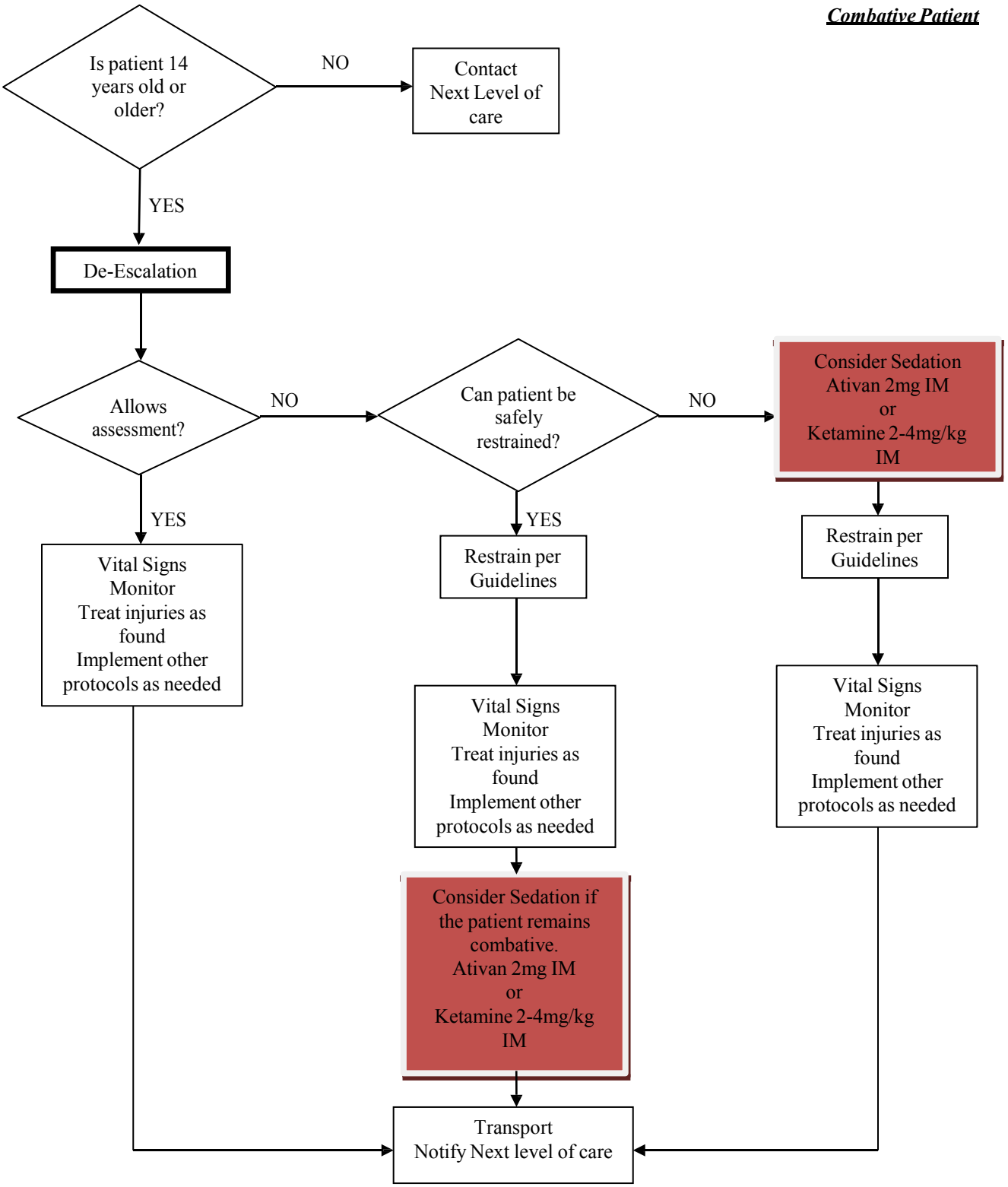
C. Warnings/Alerts:

1) All patients who receive chemical restraints shall be physically restrained.

2) Consider closed head injury/brain bleed in cases of combative patients. Complete neurologic assessment shall be completed and documented.

3) Providers shall avoid using any other restraints other than the once listed.

Combative Patient


Is patient 14 years old or older?
NO
Contact Next Level of care
YES
De-Escalation
Allows assessment?
NO
Can patient be safely restrained?
NO
Consider Sedation Ativan 2mg IM or Ketamine 2-4mg/kg IM
YES
YES
Restrain per Guidelines
Restrain per Guidelines
Vital Signs Monitor Treat injuries as found Implement other protocols as needed
Vital Signs Monitor Treat injuries as found Implement other protocols as needed
Vital Signs Monitor Treat injuries as found Implement other protocols as needed
Consider Sedation if the patient remains combative. Ativan 2mg IM or Ketamine 2-4mg/kg IM
Transport Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

13. ***Crush Syndrome***

A. Objectives:

1) To assess and appropriately treat patients with suspected crush injuries/syndrome.

B. General Information:

1) Entrapped patients under heavy loads greater than 30 minutes shall be treated as suspected crush syndrome.

2) Serious signs and symptoms are:
- Hypotension
- Hypothermia
- Abnormal ECG findings
- Pain
- Anxiety

C. Warnings/Alerts:

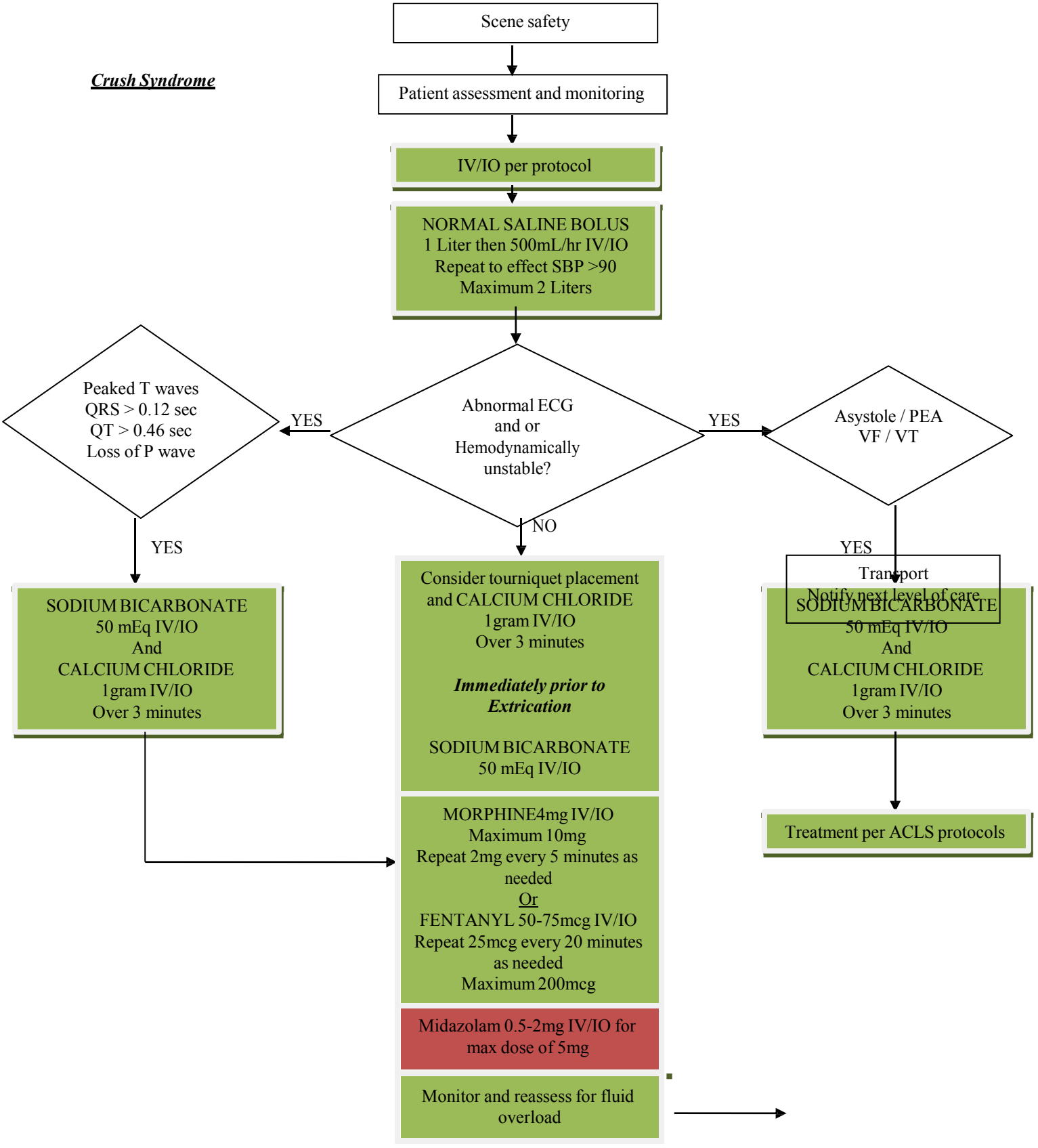
1) Scene safety is of paramount importance as typical scenes pose hazards to rescuers. Call for appropriate resources.

2) Avoid Ringers Lactate IV solution due to potential worsening of hyperkalemia.

3) Hyperkalemia from crush syndrome can produce ECG changes described in protocol, but may also be a bizarre wide complex rhythm. Wide complex rhythms should also be treated using VF/Pulseless VT Protocol with the focus on hyperkalemia.

4) Patients may become hypothermic even in warm environments.

Crush Syndrome



III. ADULT PATIENT CARE PROTOCOLS

14. *Dialysis/ Renal Failure*

A. Objectives:

1) To assess and appropriately treat patients who receive dialysis.

B. General Information:

1) Dialysis patients are very susceptible to electrolyte imbalances and hypoglycemia.

2) Serious signs and symptoms of electrolyte imbalances are:
- Weakness
- Chest pain / pressure
- Peaked T waves on an EKG
- Hypo/Hypertension
- Pulmonary Edema
- Headaches
- Dizziness

3) Blood pressure and IV's shall not be taken or given on extremities with shunts.

4) Bleeding from shunts can be difficult to control, do not apply tourniquet directly on top of shunt. If possible, apply tourniquet above the affected area.

5) For cardiac arrest in dialysis patients, calcium chloride 1g IV/IO followed by 40ml flush and sodium bicarbonate 1 meq/kg IV/IO should be administered as first line medications.

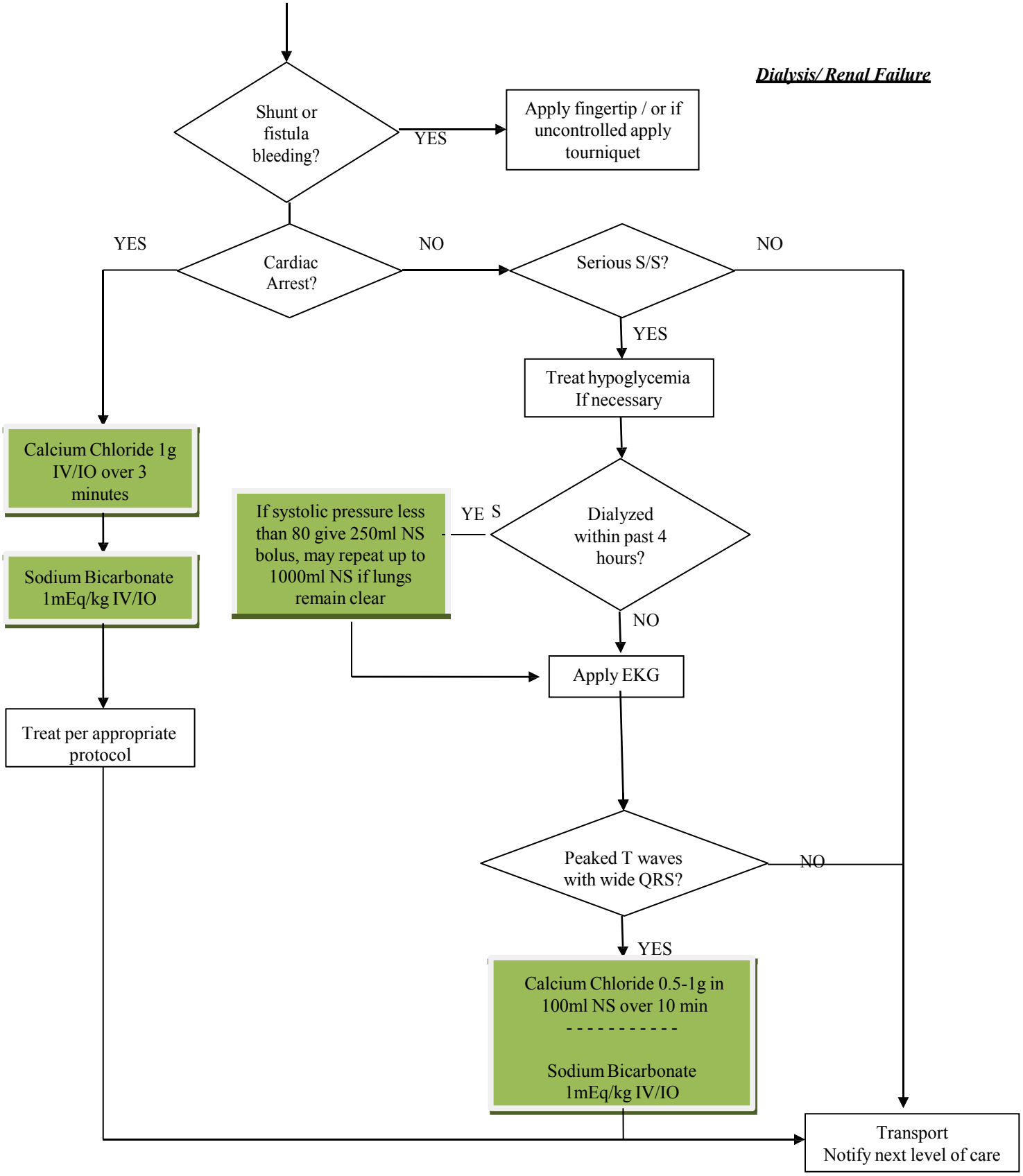
C. Warnings/Alerts:

1) Do not use tourniquets directly on shunt or fistula.

2) Do not give magnesium sulfate to renal failure patients.

3) Flush IV lines thoroughly between sodium bicarbonate and calcium chloride administration.

Dialysis/ Renal Failure


Shunt or fistula bleeding?
YES
Apply fingertip / or if uncontrolled apply tourniquet
YES
Cardiac Arrest?
NO
Serious S/S?
NO
YES
Treat hypoglycemia If necessary
Calcium Chloride 1g IV/IO over 3 minutes
Sodium Bicarbonate 1mEq/kg IV/IO
If systolic pressure less than 80 give 250ml NS bolus, may repeat up to 1000ml NS if lungs remain clear
YE S
Dialyzed within past 4 hours?
NO
Apply EKG
Treat per appropriate protocol
Peaked T waves with wide QRS?
NO
YES
Calcium Chloride 0.5-1g in 100ml NS over 10 min
- - - - - - - - - - -
Sodium Bicarbonate 1mEq/kg IV/IO
Transport
Notify next level of care

III. ADULT PATIENT CARE PROTOCOLS

15. *Diving Medical Disorders / Flight Physiology Events*

A. Objectives:

1) To assess and appropriately treat patients who are experiencing a diving medical disorder

B. General Information:

1) Altitude precautions shall be considered in transporting these patients.

2) 100% O_2 via non rebreather if patient is conscious shall be applied, to flush out all N2 from the blood stream.

3) The patients diving gear shall be transported with the patient. (I.E tanks, depth gauge, dive watch, rebreathing apparatus, etc…)

4) Maintain Carboxyhemoglobin levels via RAD57 Device at 1-5%. Any reading over 5% after a Flight Physiology event shall be placed on 100% O_2 via NRB until levels are less than 5%.

C. Warnings/Alerts:

1) Transport patients in supine position.

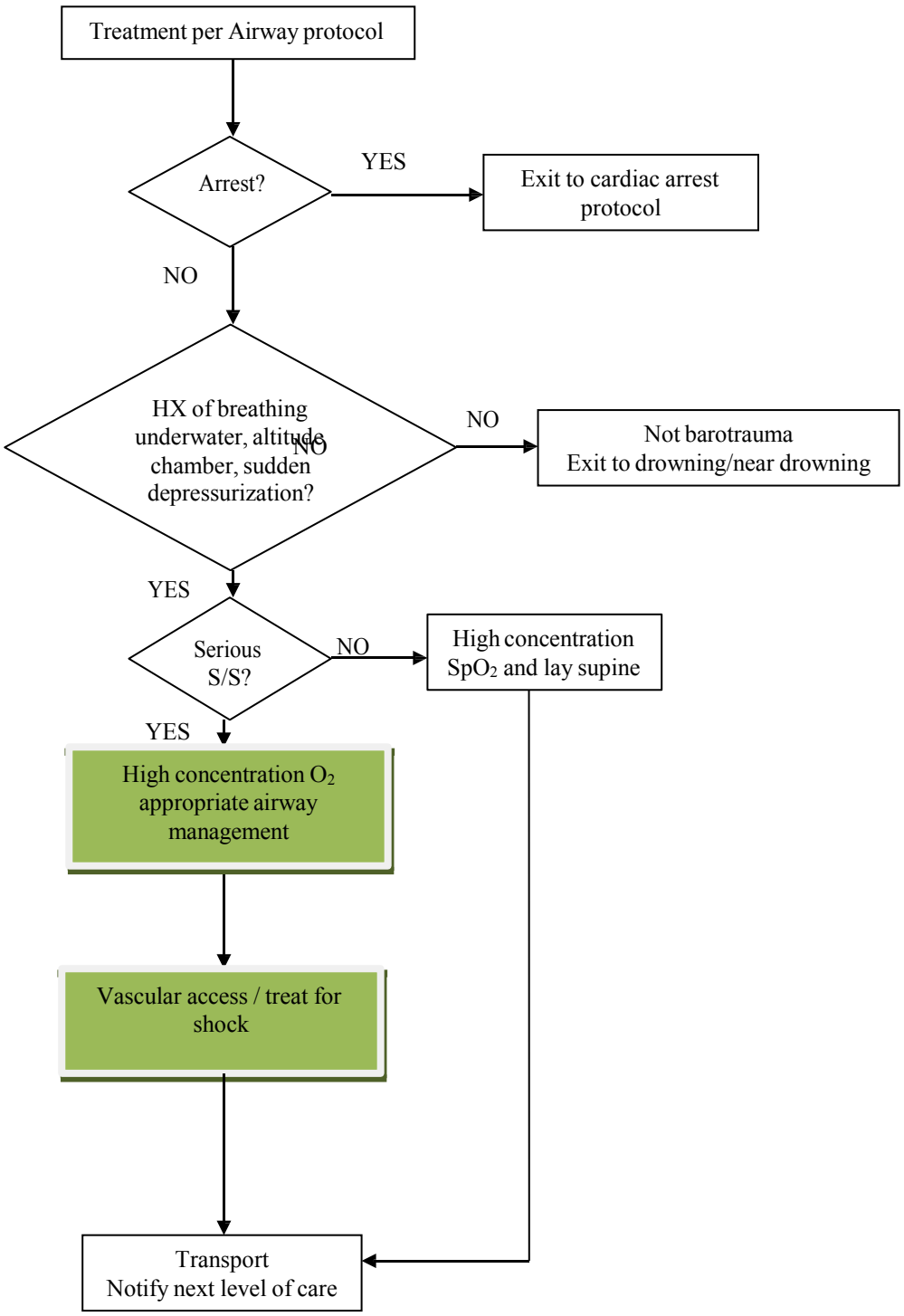
2) Only transport to facilities with hyperbaric chambers in local area.
Diving Alert Network (Duke University): 919-684-9111
For information on closest chamber: http://www.diversalertnetwork.org/

3) Increasing altitude for these patients can severely increase signs and symptoms or cause fatal harm.

D. Notes:

1) Dive Medical HX:
   a. Type of dive performed, depth, duration.
   b. Number of dives in the last 24hrs.
   c. When were the symptoms noticed: Before, during, or after the dive.
   d. Was it during descending, the bottom or ascending?
   e. Has the symptom/s increased, decreased, or stayed the same.
   f. Have you ever had DCS or AGE before, when?

Diving Medical Disorders



III. ADULT PATIENT CARE PROTOCOLS

16. *Drowning / Near Drowning*

A. Objectives:

1) To assess and appropriately treat patients who have experienced a submersion injury.

B. Warnings/Alerts:

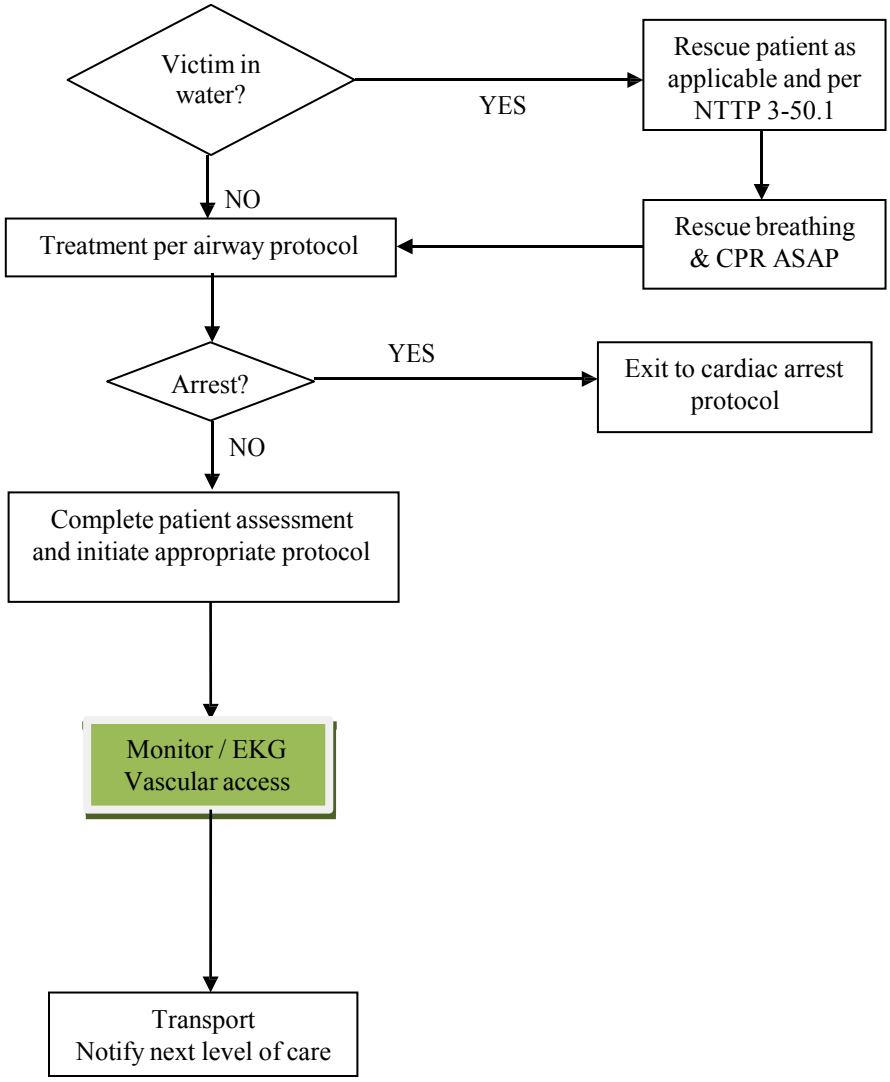
1) All patients with submersion incidents shall be transported for evaluation. Patients are in high risk of developing life-threatening pulmonary edema within 72 hours of incident.

2) Do not insert an NG tube without securing the airway with an ET tube.

3) Patients shall be considered for C-spine precautions, as diving injuries are associated with spinal injury.

4) Drowning is the leading cause of death among would-be rescuers.

Drowning / Near Drowning



III. ADULT PATIENT CARE PROTOCOLS

17. ***Head Injury / Suspected TBI***

A. Objectives:

1) To appropriately assess, treat, and manage patients with head injuries / suspected traumatic brain injuries.

2) To maintain adequate airway and oxygenation, maintain $EtCO_2$ 35-40 mmHg.

3) Establish and maintain adequate perfusion to vital organs or to sustain life until further care.

4) Appropriately administer the Military Acute Concussion Evaluation (MACE).

B. General Information:

1) Little that can be done to correct the primary injury in the prehospital environment. The primary goal is to prevent secondary injuries associated with hypoxia, hypotension, anemia, and both hyper/hypothermia.

2) The hallmark sign is altered level of consciousness. The optimal assessment includes AVPU, neurological evaluation, and MACE 2 exam.

3) The use of low altitude flight shall be considered in transportation of these patients.

C. Warnings/Alerts:

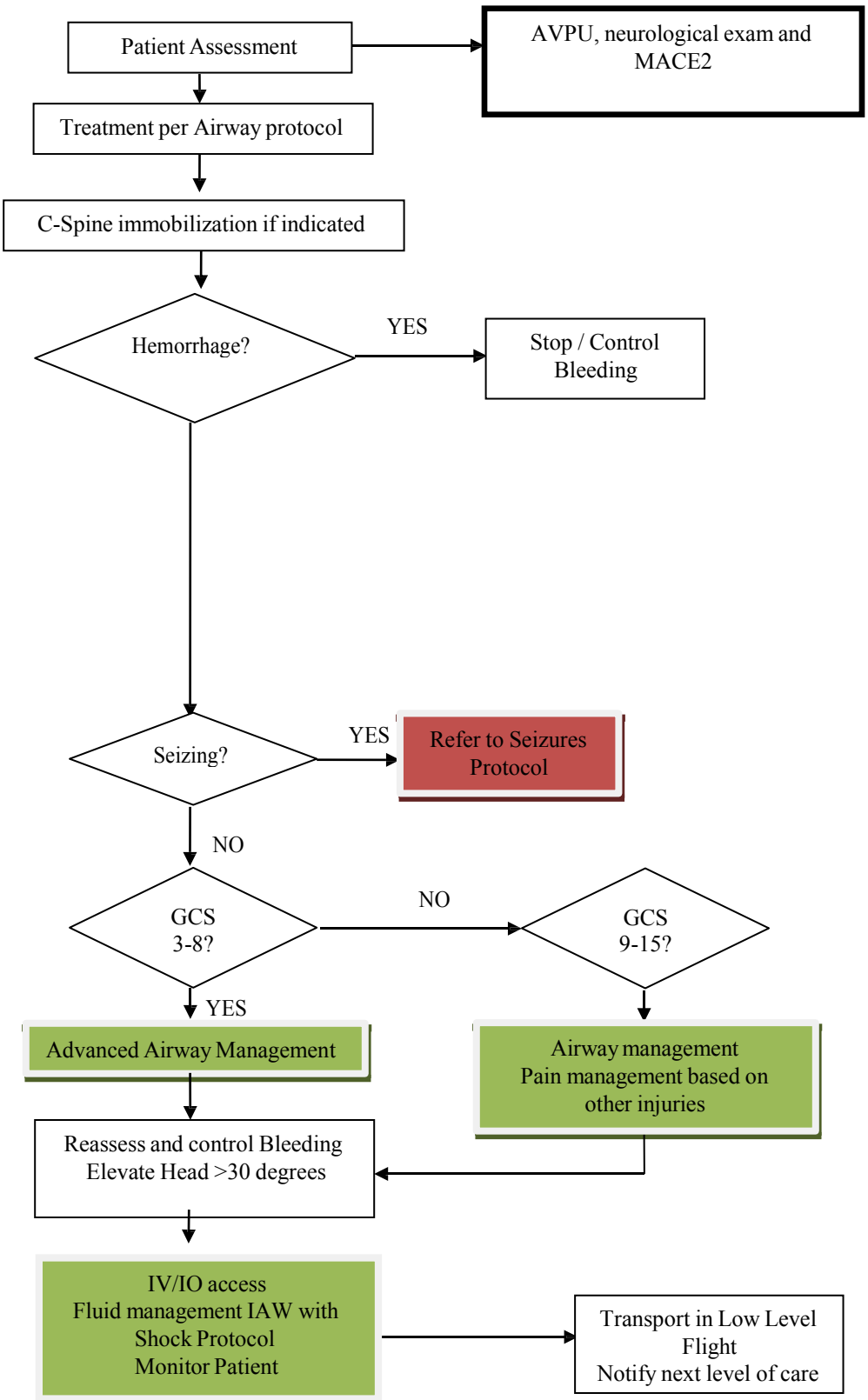
1) Do not elevate the feet to treat for shock.

2) Administer fluids to maintain MAP of 85mmHg.

3) There are many medications with contradictions associated with ICP, with most of them being Analgesics. Be cautious in the medication given and consult OMD or the medication reference in the back of these protocols for further guidance.

4) Hyperventilation is NOT recommended in treatment of these patients.

Head Injury / Suspected TBI



Refer to XI. MILITARY ACUTE CONCUSSION EVALUATION

(MACE) 2ND EDITION on page 206, for all suspected Head Injury

and Traumatic Brain Injury patients that ARE DOD entities.

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III. ADULT PATIENT CARE PROTOCOLS

18. *Hyper / Hypoglycemia*

A. Objectives:

1) To assess and appropriately treat patients with Hyper / Hypoglycemia.

B. General Information:

1) Dextrose 50% may be administered rectally.

2) Dextrose administration requires a patent IV line, not a saline lock.

3) Malnourished patients or suffering from severe dehydration may need Thiamine to properly metabolize dextrose.

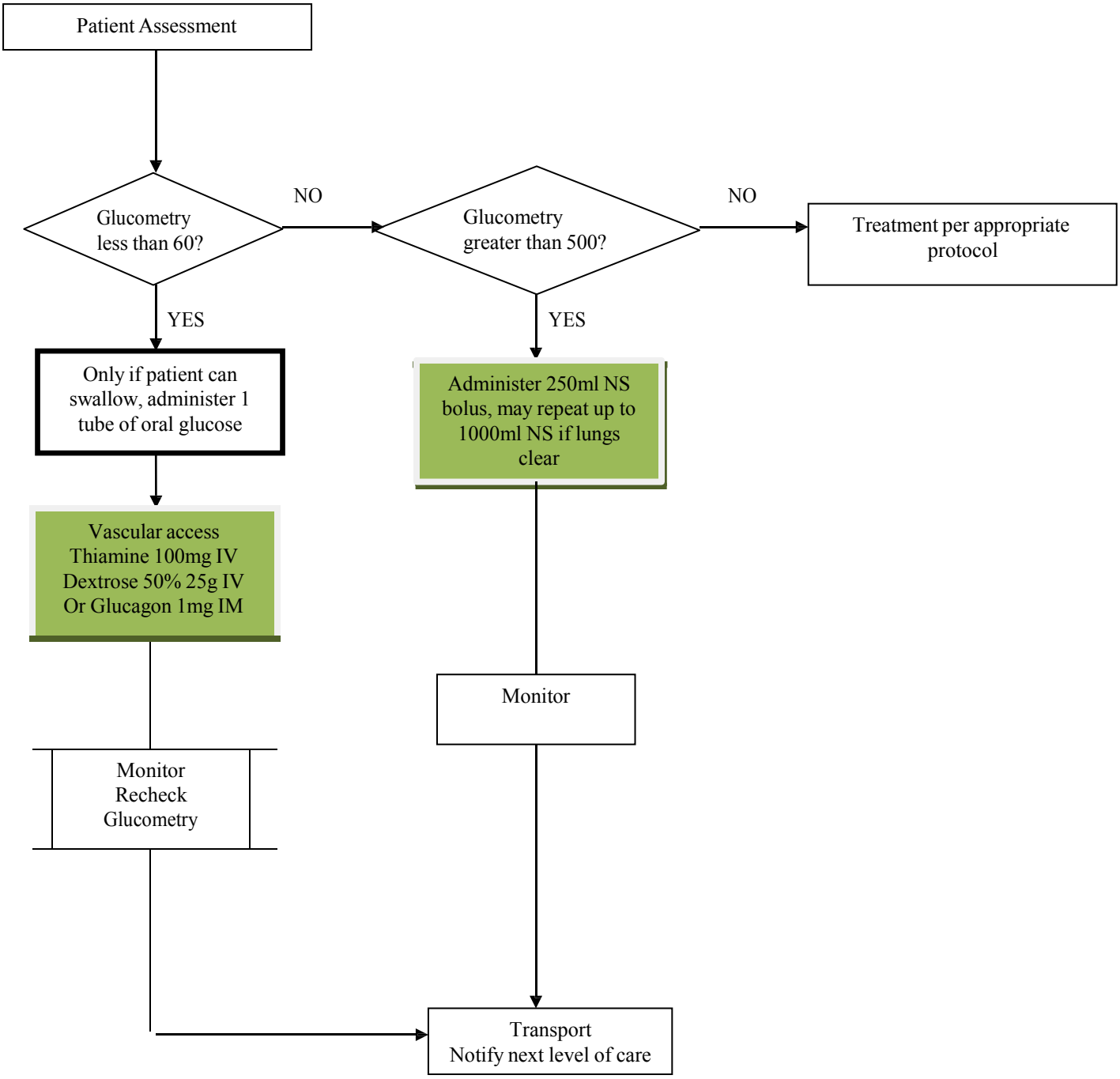
C. Warnings/Alerts:

1) Do not administer oral glucose to patients that are not able to swallow or protect their own airway.

2) If the IV line infiltrates while administering Dextrose, stop dextrose administration immediately.

3) Patients shall have their weapons removed for patient safety.

Hyper / Hypoglycemia



III. ADULT PATIENT CARE PROTOCOLS

19. *Hyperthermia*

A. Objectives:

1) To assess and appropriately treat patients who are hyperthermic.

B. General Information:

1) Administer oral fluids if patient can swallow – water and half-strength electrolyte solution

2) Active cooling measures:
- Air moving across wet skin
- Ice packs at axilla, groin, neck
- Doors and windows of aircraft should be open based on environment to help cooling

C. Warnings/Alerts:

1) Heat stroke is a life-threatening emergency, do not delay transport.

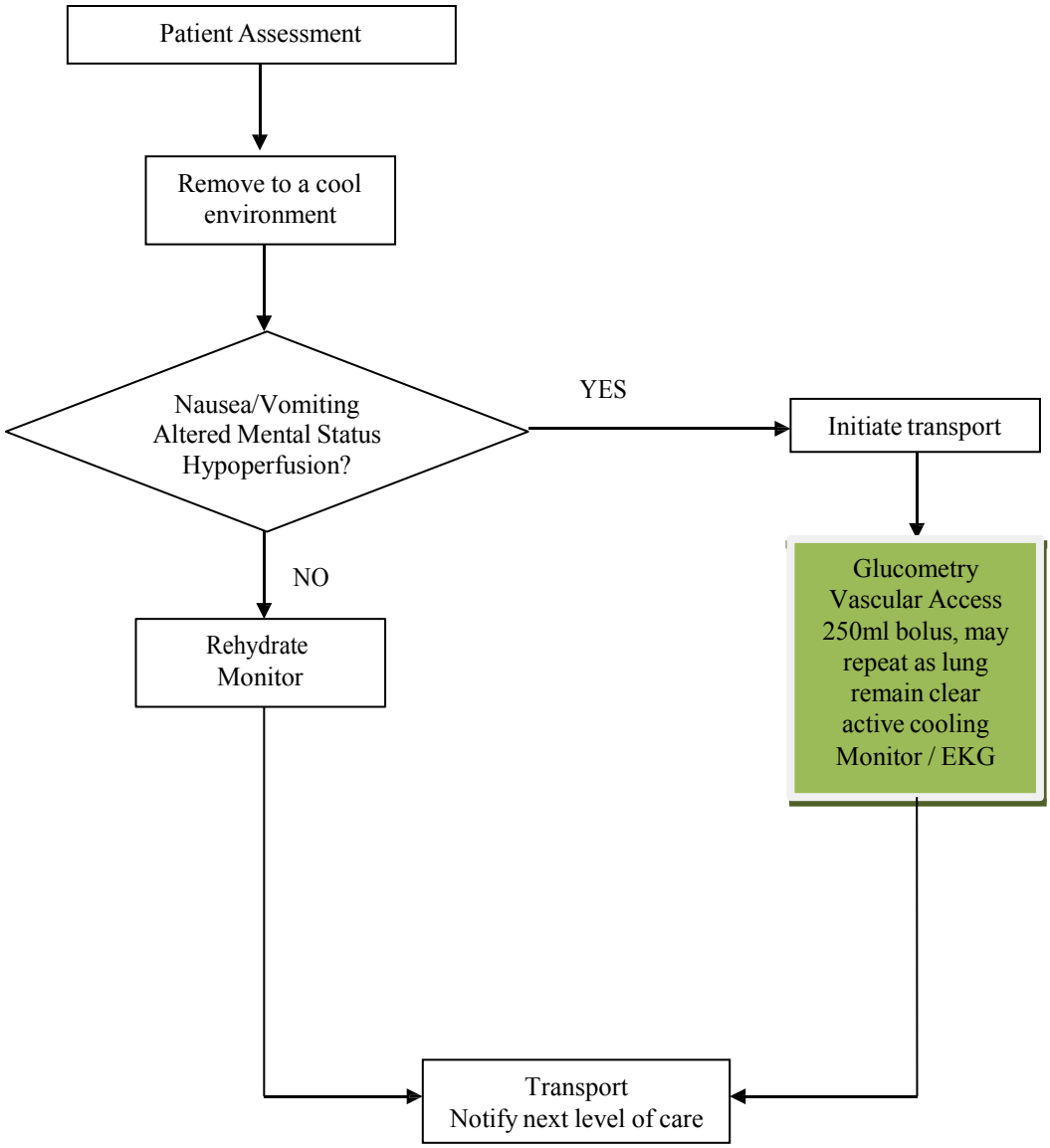
2) Patients shall have their weapons removed for patient safety.

3) Do not exceed 2000ml of IV fluids unless directed to by Medical Control.

4) Cease active cooling when core temperature has been lowered to102 degrees F and continue to monitor.

5) Cocaine, ecstasy, amphetamines, and aspirin toxicity can all raise body temperatures.

Hyperthermia



III. ADULT PATIENT CARE PROTOCOLS

20. *Hypothermia*

A. Objectives

1) To assess and appropriately treat patients who are hypothermic.

B. General Information:

1) Remove all of the patient's wet clothing.

2) Cover the patient with blankets or Hypothermia Kits.

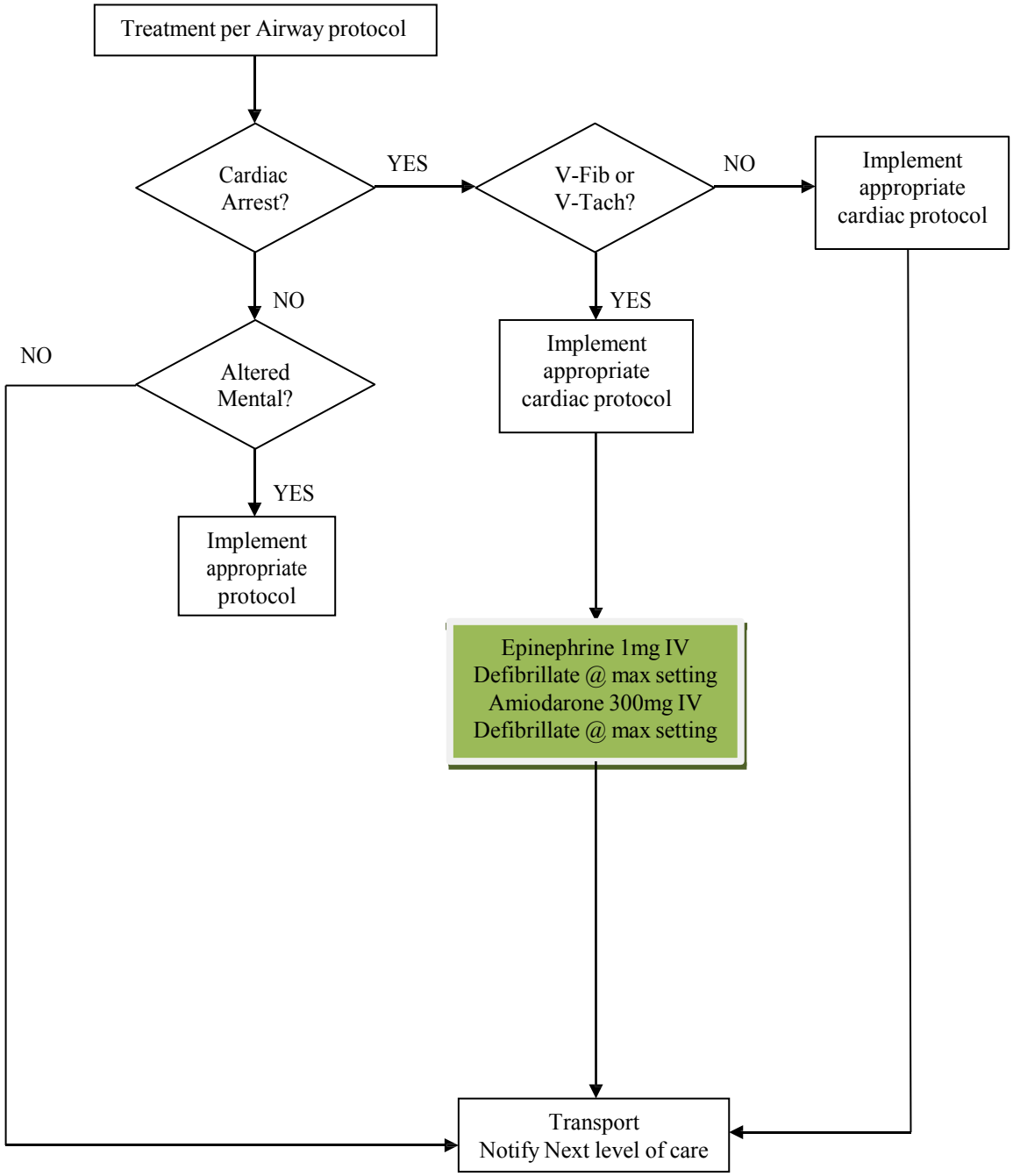
3) Hypothermia is defined as a core temperature <95F (35C)
- With temperatures <31C (88F) ventricular fibrillation is common. Cardiac muscle is very irritable and rough handling of patients at these temperatures can result in cardiac dysrhythmias.
- Core temperatures below 30C (86F) ceases shivering.

C. Warnings/Alerts:

1) 1) Handle hypothermic patients gently to avoid spontaneous conversion into ventricular fibrillation. Avoid aggressive rewarming, sudden movements, and/or rough handling in severe hypothermia patients.

2) Severe hypothermic patients can present with Rigor Mortis. Providers should attempt resuscitation unless clear evidence of irreversible death.

Hypothermia



III. ADULT PATIENT CARE PROTOCOLS

21. *Nausea / Vomiting*

A. Objectives

1) To assess and appropriately treat patients who are profoundly nauseous and vomiting.

B. General Information:

1) Nausea and Vomiting generally are not life-threatening conditions.

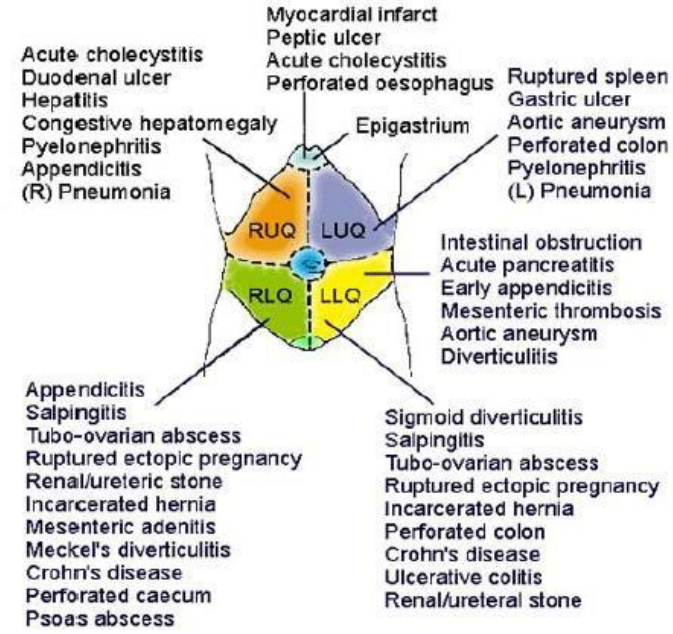
2) Suction should be readily available.

3) Zofran (Ondansetron) or Phenergan (Promethazine) may be administered to patients with vomiting. Medication is highly recommended for in-flight transport.

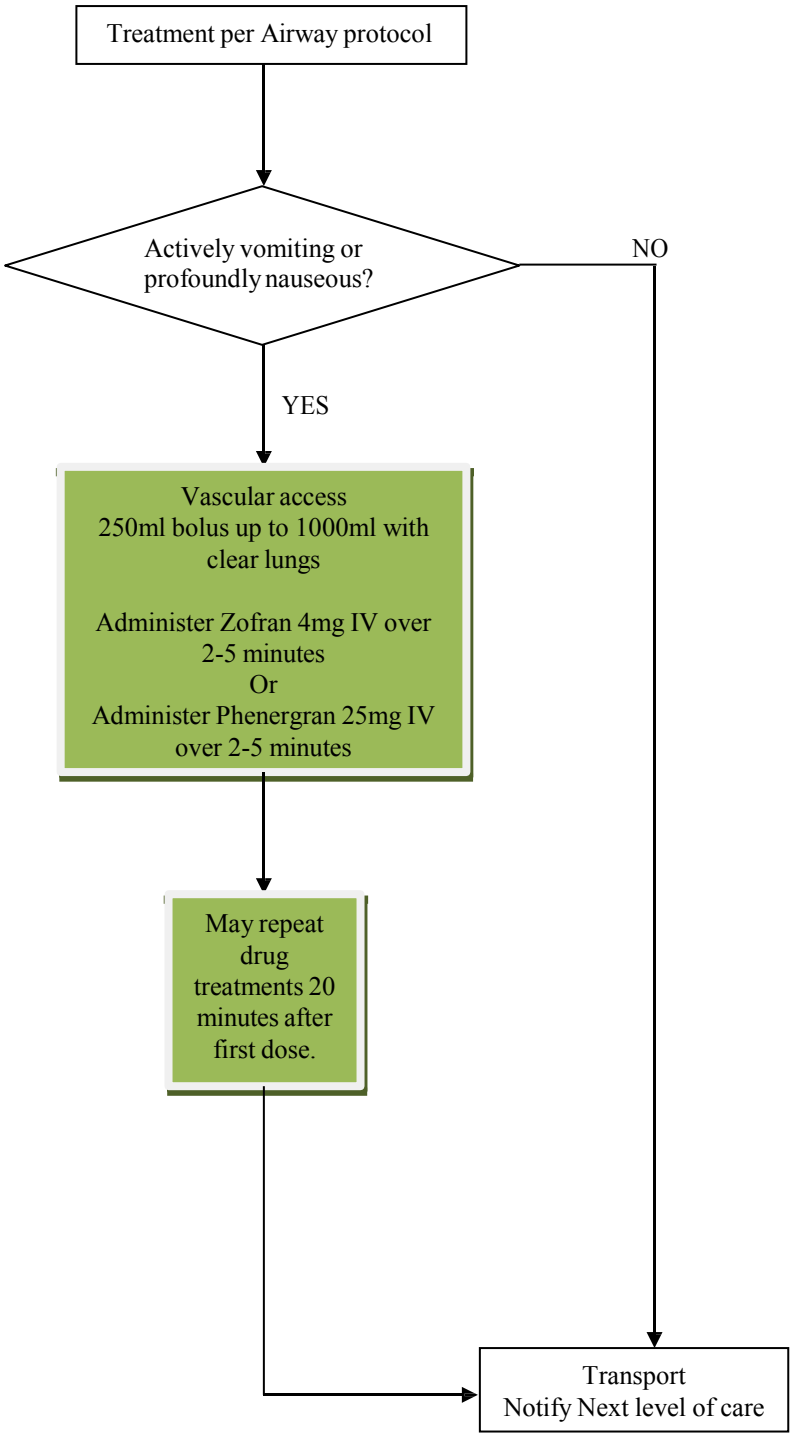
4) Zofran – 4mg slow IV push or IM if IV not available
Phenergan – 25mg IV push or IM if IV not available

C. Warnings/Alerts:

1) Ventilating an unconscious vomiting patient will produce aspiration and airway obstruction, suctioning and advanced airway management is essential.



Nausea / Vomiting


Treatment per Airway protocol
Actively vomiting or profoundly nauseous?
NO
YES
Vascular access
250ml bolus up to 1000ml with clear lungs
Administer Zofran 4mg IV over 2-5 minutes
Or
Administer Phenergran 25mg IV over 2-5 minutes
May repeat drug treatments 20 minutes after first dose.
Transport
Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

22. ***OB / GYN – Pregnancy / Delivery / Vaginal Bleeding***

A. Objectives

1) To appropriately access and manage out-of-hospital births.

2) To appropriately access and manage patients with vaginal bleeding.

B. General information:

1) Obtain functional HX:
- Premature?
- Multiple births?
- Meconium?
- Prenatal care?
- Narcotic use?

2) Transport patients in left lateral recumbent position.

3) Vaginal bleeding is considered moderate to severe if the patient has lost more than 500ml of blood or if she is using 1 heavy pad/hour or more.

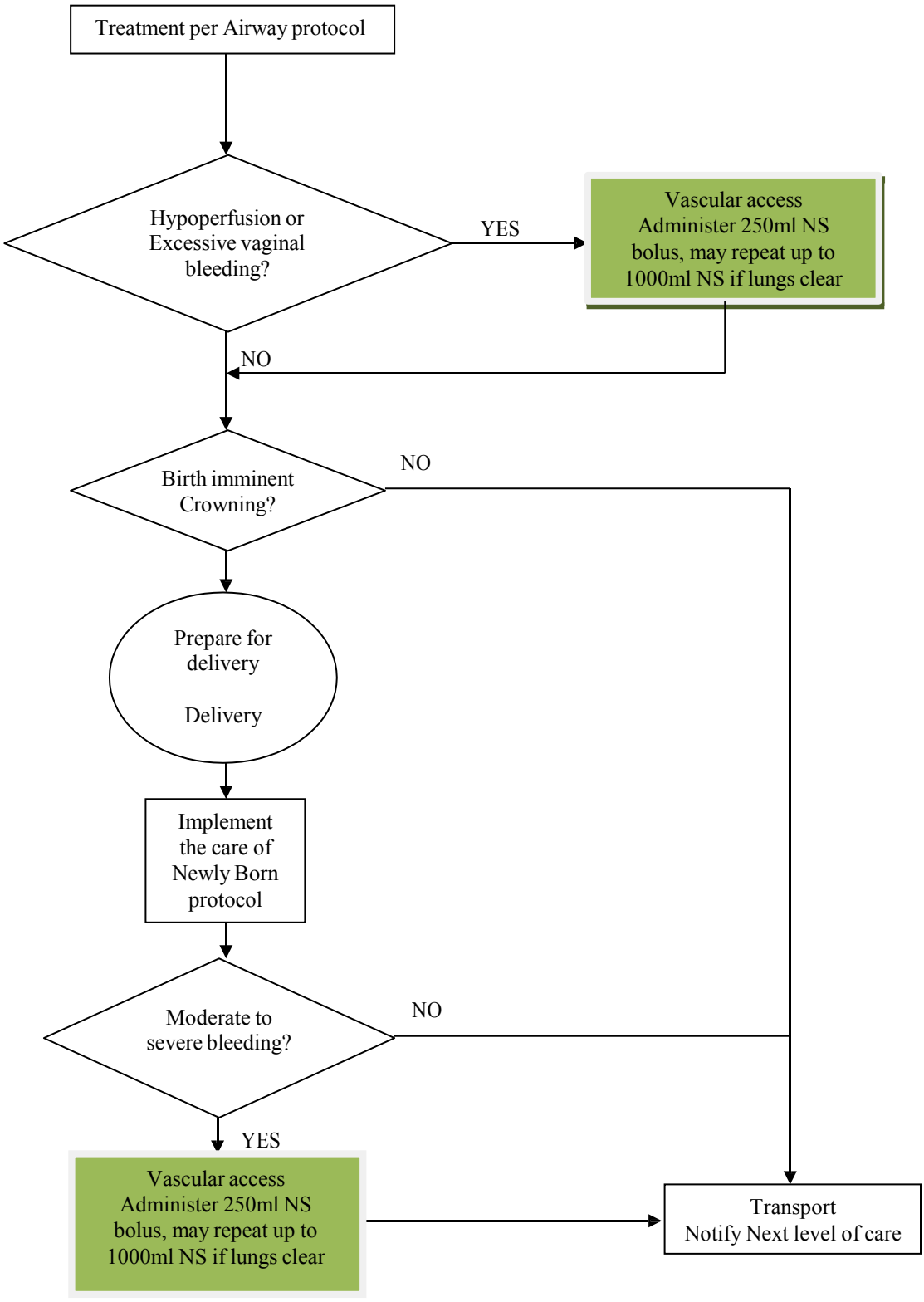
4) With severe vaginal bleeding post birth, consider uterine massage for placental delivery.

C. Warnings/Alerts:

1) Do not assume that vaginal bleeding is due to normal menstruation.

2) Third-trimester bleeding is never normal and can be life-threatening to the mother and fetus.

OB / GYN – Pregnancy / Delivery / Vaginal Bleeding


Treatment per Airway protocol
Hypoperfusion or Excessive vaginal bleeding?
YES
Vascular access Administer 250ml NS bolus, may repeat up to 1000ml NS if lungs clear
NO
Birth imminent Crowning?
NO
Prepare for delivery
Delivery
Implement the care of Newly Born protocol
Moderate to severe bleeding?
NO
YES
Vascular access Administer 250ml NS bolus, may repeat up to 1000ml NS if lungs clear
Transport Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

23. *OB / GYN – (Pre) Eclampsia*

A. Objectives

1) To appropriately access and treat patients with pre-eclampsia or eclampsia.

B. General Information:

1) Pre-eclampsia may occur for up to 18weeks pre-birth - 8weeks post-partum.

2) Ativan (lorazapam) is preferred drug for seizures
- Dose is 2mg slow IV push, dilute in NS

Valium (Diazepam) is first line treatment for seizing patients
- Dose is 5mg slow IV push over 2 minutes

Magnesium Sulfate is treatment to control eclampsia
- Dose is 2g in 100ml over 5 minutes

3) Transport patient in left lateral recumbent position.

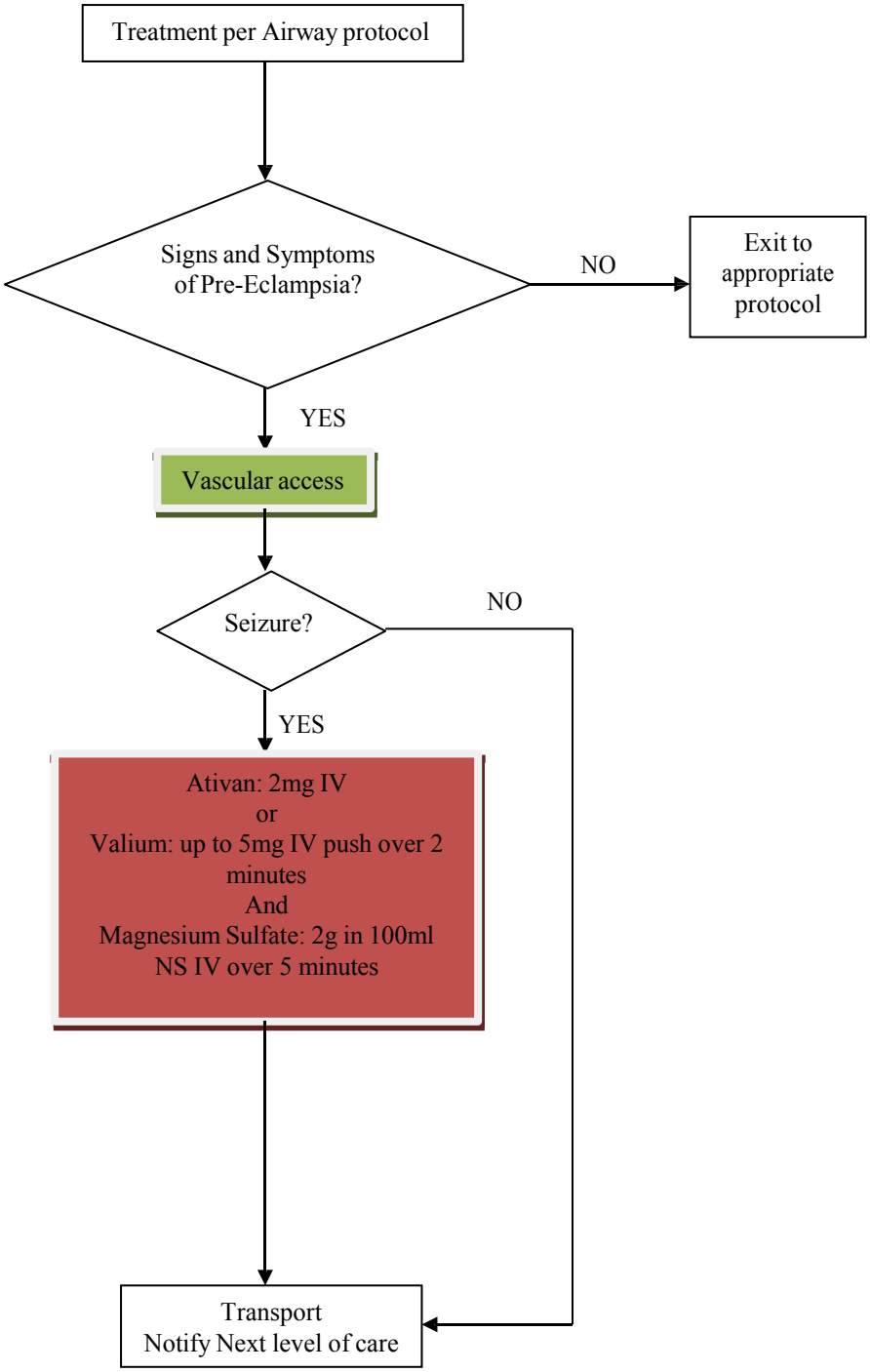
C. Warnings/Alerts:

1) Use caution in administering magnesium sulfate to patients in renal failure.

2) Valium has the potential to cause respiratory depression and bradycardia, patients shall be monitored. After Valium administration, flush IV lines thoroughly.

3) Monitor closely for elevated blood pressure based on the patient's normal baseline.

OB / GYN – (Pre) Eclampsia



III. ADULT PATIENT CARE PROTOCOLS

24. *Pain Management Non-Cardiac*

A. Objectives

1) To assess and appropriately treat non-cardiac pain.

B. General Information:

1) Pain is an important indicator of disease or injury, but generally under treated in the prehospital environment. Pain management is associated with a reduction in PTSD symptoms after traumatic injury.

2) Pain management medications:
- Morphine: 2mg IV or IM with a maximum total dose 10mg
- Should be administered via slow IV push

- Fentanyl: 1mcg/kg, for a max dose of 100mcg.
- Shall be slow IV push
- May be used IM or IN.

- Ketamine: 20mg IV/IO over 1 minute
50mg IM
50mg Intranasal / Atomizer every 30-60min as needed for severe pain

3) Implement Nausea / vomiting protocol as needed.

C. Warnings/Alerts:

1) Patients who receive pain medications shall receive cardiac and SpO_2 monitoring.

2) Naloxone shall be on hand with the administration of opioid medications to counter-act respiratory depression.
- Naloxone: 0.4-2mg titrated to effect, or respiratory depression improves.

3) The mixing the of analgesics should be avoided in pain management. In the event mixing of analgesics, documentation of why needs to be completed on the DA4700.

Treatment per Airway protocol

Assess pain and severity

Mild/Moderate pain 1-5?

Severe pain 6-10?

Vascular access

Fentanyl 1mcg/kg IV/IO, for a max dose of 100mcg fix

Vascular access

Fentanyl 1mcg/kg IV/IO, for a max dose of 100mcg

Or

Ketamine 20mg IV/IO
50mg IM/IN

Nausea / Vomiting protocol as needed

Transport
Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

25. *Post-Operative & CC Interfacility Transfer*

CLINICAL INDICATIONS:

- Patient at outlying MTF requiring transfer to higher role of care for more definitive surgery/treatment

PRE-TRANSFER Patient Status Requirements:

a. JTS CPG – Intra-theater Transfer and Transport – recommends clinical parameters that should be met prior to transfer; if parameters are not met, they should be addressed and en-route mitigation plans formulated BEFORE departure / transfer:
   1) Heart rate 50><120 bpm
   2) SBP 70-80mmHg, MAP >60mmHg (permissive hypotension)
   3) If elevated ICP or CPP, maintain MAP 80><110mmHg, SBP 110><160mmHg
   4) Hematocrit >24% (or Hgb >8g/dL)
   5) Platelet count >50/mm^3
   6) INR <2.0
   7) pH >7.3
   8) Base deficit <5mEq/L
   9) Temperature >35.5ºC or 96ºF
   10) $ETCO_2$ 35><45, SPO_2 ≥92%, and/or $PaCO_2$ 35><45mmHg

If these criteria are not met, the transferring physician should continue resuscitation or provide documentation indicating limitations that compel urgent transfer. This can be documented in the comments section of the Standard Order Set for Critical Care Transfers document.

b. The four *MINIMUM* requirements which will be met prior to patient transfer are hemorrhage control, adequate shock resuscitation (SBP 70-80 mmHg, MAP >60 mmHg, UOP >0.5 mL/kg/hr, and/or BD <2, Temp >97ºF and <100ºF), stabilization of fractures, and initial post-operative recovery.
c. Attempt to keep patient packaging time at <25 minutes; use of warming devices in accordance with the JTS Hypothermia Prevention CPG.
d. Movement of Deceased Patients:
   1) In general, patients who meet clinical criteria for death are not to be transported by MEDEVAC, with the exception of extreme extenuating circumstances, such as emergency exfiltration during CSAR.
   2) If vital signs are absent prior to launch, make all reasonable attempts to resuscitate as clinical and tactical circumstances permit. If unsuccessful, consider basic cardiac ultrasound (as available) to determine whether any signs of cardiac activity are present. If absent, mission abort is warranted.

3) In such circumstances, contact and consultation with medical control or other available physician is suggested, in order to facilitate field determination of death and cessation of resuscitative efforts.

PROCEDURE:

a. **Role 2/3 provider responsibilities:**

It is the **responsibility of the transferring physician to write enroute care orders** appropriate for the transport environment and individualized for each patient in consultation with the Critical Care Flight Paramedic and/or the ECCN (or attending Flight Provider) prior to launch. The Flight Paramedic / Provider should be given a Standard Order Set for Critical Care Transfers or similar document with en route care orders signed by the transferring physician.

1) Provide a complete report to Flight Paramedic / Provider.
2) Provide all patient-specific related medical records.
3) Assist Flight Paramedic / Provider with packaging patient for transport as requested.
4) Complete specified areas on the appropriate patient care report
   i. Administrative data
   ii. Most current laboratory data
   iii. Mechanism of Injury (MOI)
   iv. Diagnosis
   v. Procedures
5) Place patient on ventilator at least 30 minutes prior to flight. Obtain pre-flight ABG to ensure patient tolerates ventilator settings.
6) It is strongly suggested that the transferring physician make every possible attempt to contact and discuss the case with the receiving physician or facility representative. Flight Paramedics and ECCNs should confirm or encourage this vital "physician-to-physician hand-off" if practicable.

b. **FLIGHT PARAMEDIC / PROVIDER responsibilities prior to transfer:**

1) Obtain orders for en route care from transferring physician; review orders and discuss potential en route problems with transferring physician, reconcile medications (ensure needed medications, specific to patient's condition, are obtained and prepared), allergies and patient's weight, confirm patient's identification, and secure personal effects.
2) Perform primary & secondary assessment ensuring an understanding of the patient's injuries / illness / procedures performed.
3) Spinal immobilization is indicated during transfer if ordered by transferring physician.
4) Assess placement and secure all tubes, lines, and drains & ensure proper functioning.
5) Ensure endotracheal tube is secure; secure pulse oximeter / $ETCO_2$ monitor.

6) Review ABG – ABG should be done within 30 minutes of flight; patient should be on transport ventilator with vent settings for transport; ABG obtained 15 minutes after being placed on transport ventilator.
7) Ensure vascular access X 2 - peripheral, central or IO and A-line as needed.
8) Check all bandages, splints, dressing, fixation devices and tourniquets for placement and ensure no evidence of ongoing hemorrhage.
9) If indicated, insert OG/NG tube for gastric decompression, especially in intubated patients; cap or place to suction.
10) Empty Foley catheter bag prior to flight; ensure UOP documentation by transferring facility.
11) For an intubated patient, provide adequate analgesia and sedation PRIOR to giving additional paralytic medications. Re-dose medications as needed prior to flight in accordance with transferring physician's orders.
12) Continue administration of blood products if ordered by transferring physician. If anticipated administration of blood products enroute, Flight Paramedic/Provider should request orders for blood products and appropriate blood products from the transferring physician and use FDA approved fluid warming device as appropriate for warming fluids.
13) Collect all patient care documentation for transport with patient, i.e. pre-hospital, transport, labs, x-rays, transferring facility notes, etc.
14) Remove all air from IV fluid bags and place all free flowing bags in pressure bags.
15) Ensure patient is properly packaged in a warming device unless contraindicated prior to transfer. Follow directions specific to each warming device ensuring over heating or thermal burns do not occur. Hypothermia, acidosis and coagulopathy constitute the "triad of death" in trauma patients.
16) Securely affix all equipment, supplies, loose tubing and lines to NATO litter prior to moving the patient to the vehicle or aircraft.
17) Once patient is packaged, ensure all lines are leveled and monitors are zeroed.
18) Provide eye and ear protection to patient.

Special considerations:

1) Eye Trauma: Fox shields should be placed for any patient with a suspected or confirmed open globe, possible intraocular foreign body or eye injury. Avoid placing dressing under the Fox shield and manipulation of the injured eye. Both the injured and uninjured eye should be covered IOT avoid excessive movement of the injured eye which may result from involuntary convergence. Also want to avoid nausea/vomiting in these patients. (JTTS CPG - Initial Care of Ocular & Adnexal Injuries)
2) Compartment Syndrome: Patients with extremity injuries, abdominal injuries/surgery, burns, coagulopathy and those who have received massive transfusion are at risk for compartment syndrome. Ensure proper assessment prior to flight. If compartment syndrome is suspected during flight, place extremity at the level of the heart. Pain out of proportion to the injury and paresthesia are symptoms

of compartment syndrome, as well as pallor, paralysis, pulselessness, and poikilothermia. Patients who are sedated, paralyzed or have an epidural or block in place are at increased risk and require judicious hands on assessment of at risk abdomen and extremities. (JTTS CPG – Compartment Syndrome and Fasciotomy)

3) Burns: For patients with partial and/or full-thickness burns to > 20% TBSA, use of the Burn Patient Admission Orders and JTTS Burn Resuscitation Flow Sheet are REQUIRED and should be continued during transfer to another facility. (JTTS CPG – Burn)
4) Advanced pain management modalities: For patients with epidurals, continuous peripheral nerve blocks, PCA infusions, or other pain medicine infusions, a pain note should be completed prior to transport as it is a vital part of provider communication. (JTTS CPG – Management of Pain, Anxiety and Delirium in Injured Warfighters)
5) Sedation and pain management must be maintained at appropriate levels throughout transport. As appropriate and as directed by transferring physician, attempt to maintain sedation target as follows using the Riker Sedation-Agitation Scale (SAS)

Post-Operative & CC Interfacility Transfer

Riker Sedation-Agitation Scale (SAS): Used as sedation target goal for Post Surgical / CC

- Non-intubated patients, provide sedation as needed to maintain a goal SAS Score of 3-4.
- Intubated patients, provided sedation as needed to maintain a goal SAS Score of 1-2.

		Definition
7	Dangerous agitation	Pulling at endotracheal tube, trying to remove catheters, climbing over bedrail, striking at staff, thrashing from side-to-side
6	Very agitated	Does not calm despite frequent verbal reminding of limits, requires physical restraints, biting endotracheal tube
5	Agitated	Anxious or physically agitated, attempting to sit up, calms down on verbal instructions
4	Calm, cooperative	Calm, arousals easily, follows commands
3	Sedated	Difficult to arouse, awakens to verbal stimuli or gentle shaking but drifts off again, follows simple commands
2	Very sedated	Arouses to physical stimuli but does not communicate or follow commands, may move spontaneously
1	Unarousable	Minimal or no response to noxious stimuli, does not communicate or follow commands

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d. Patient Care Enroute to the Receiving Hospital

1) Patient vital signs will be monitored continuously enroute and documented at least every 5 – 15 minutes per transferring physician's orders.
2) Reassess patient at least every 15 minutes and address events as necessary following transferring physician's orders and protocols for the specific illness or injury.
3) Assess pain control, sedation and need for paralysis. Re-dose medications as needed in accordance with transferring physician's orders. Ideally, paralytic medication should not be administered near the end of the flight. Significant, adjunctive analgesia may be required to compensate for initial lift, landing and in flight combat maneuvers, therefore Flight Paramedic/Provider should consider carrying higher volumes of analgesia that would be normally used in ground transport or fixed facilities.
4) All events will be addressed with appropriate interventions according to transferring physician's orders and protocols. All interventions require reassessment for patient response to the intervention.
5) All enroute care, including ventilator changes, medications, events, interventions, and patient's response will be documented on the appropriate patient care documentation.

e. Patient Report and Transfer of Care at the Receiving Hospital

1) A verbal and written patient report will be given to the receiving nurse or physician upon delivery of the patient.
2) Routinely, the responsibility of care will be transferred at the receiving ED. On rare occasions (i.e. mass casualty incidents, pending emergency flights, etc.), care may need to be transferred on the helipad rather than at the bedside.

Post-Operative & CC Interfacility Transfer

3) For Tail-to-Tail transfers, the Flight Paramedic/Provider initiating transport will send all documentation from the transferring facility and the patient care documentation from the first leg of the flight with the Flight Paramedic/Provider completing the second leg of the transfer. The Flight Paramedic/Provider completing the second leg of the transfer will initiate their own patient care documentation, circling "2nd Leg" at the top of the form and ensure all documentation is turned over to the MTF upon arrival and hand off of patient care.
4) The patient care documentation will be completed and left with the patient at the receiving facility at the time of patient handover. If unable to complete documentation due to extensive mission requirements, the patient care documentation will be forwarded to the appropriate medical information receiving facility/person IAW local / theater policy.

Any in-flight problems should be addressed per appropriate protocol and per written instruction from transferring physician. Continued problems should prompt contacting medical control as soon as it is possible.

Document procedure, results, and vital signs.

III. ADULT PATIENT CARE PROTOCOLS

26. ***Rapid Sequence Induction-RSI***

A. Objectives:

1) To facilitate airway management through the use of sedatives and paralytics.

B. General Information:

1) Patients presenting or have the potential for severe airway compromise require sedatives and paralytics to secure the airway.

2) Patients with the following should be considered for RSI:
- Burns to the face with suspected inhalation injury
- Severe trauma to the face that may occlude airway
- Patients who must have prolonged ventilator assistance
- GCS less than 8, with associated TBI or Head injury

C. Warnings/Alerts:

1) This procedure shall be done with at least 2 providers. Divide the work load- ventilate, suction, cricoid pressure, drugs, and intubation

2) Shall use end-tidal CO2 monitors and SpO_2 monitoring. Suspected TBI/Head trauma patients end-tidal CO2 shall be kept between 35-40 mmHg.

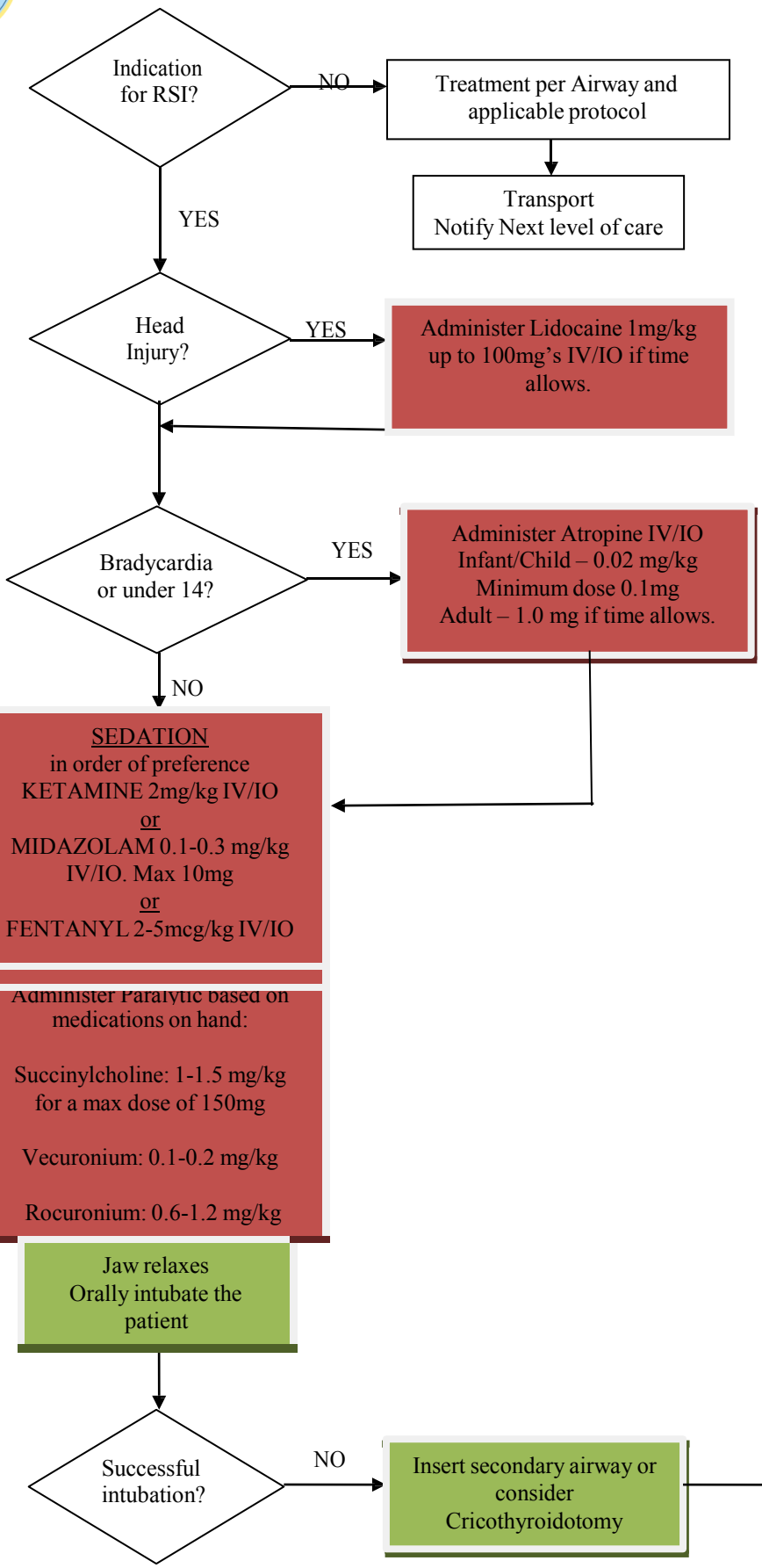
3) Protect the patient from self-extubation.

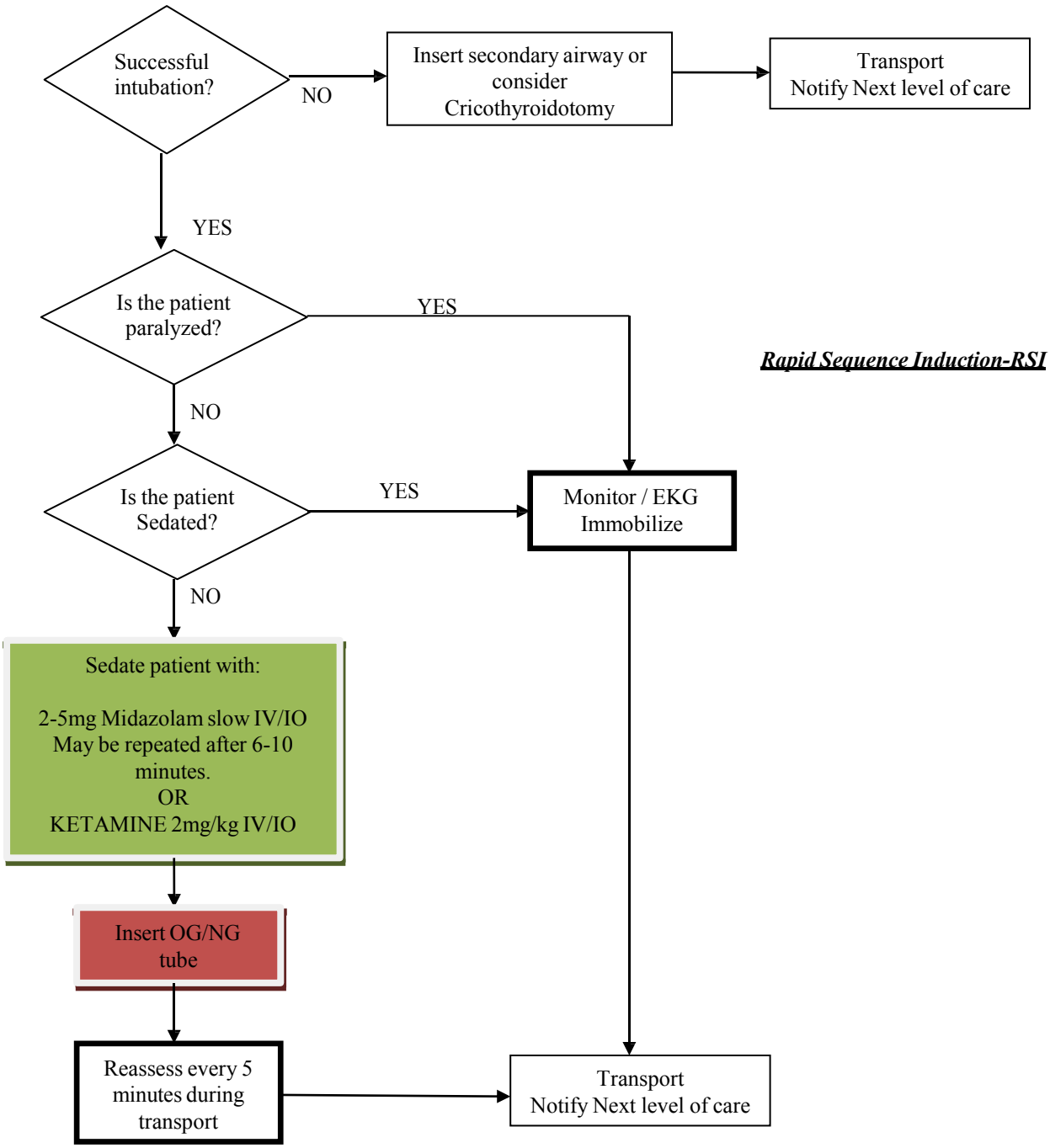
4) Do not administer Succinylcholine to patients with a HX of Malignant Hyperthermia.

5) Administration of analgesics is required on patients requiring advanced airway procedures.

6)

Rapid Sequence Induction-RSI





Rapid Sequence Induction-RSI

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III. ADULT PATIENT CARE PROTOCOLS

27. ***Seizures***

A. Objectives:

1) To assess and treat patients with seizures.

2) To protect the airway of a seizing patient.

B. General Information:

1) Medications shall only be given to patients having active seizure lasting greater than 2 minutes.

2) All patients who receive Ativan, Valium, and Versed shall have cardiac and SpO_2 monitoring.

3) - Ativan (Lorazepam) is the preferred drug for seizures.
Dilute in equal amount of NS before administration IV/IO
2mg slow push
Can be given IM/IN if no vascular access, do not dilute

- Versed (Midazolam)
2mg slow IV/IO push
Can be given IM/IN if no vascular access

- Valium (Diazepam)
Up to 5mg slow IV push IV/IO
Can be given IM/IN if no vascular access

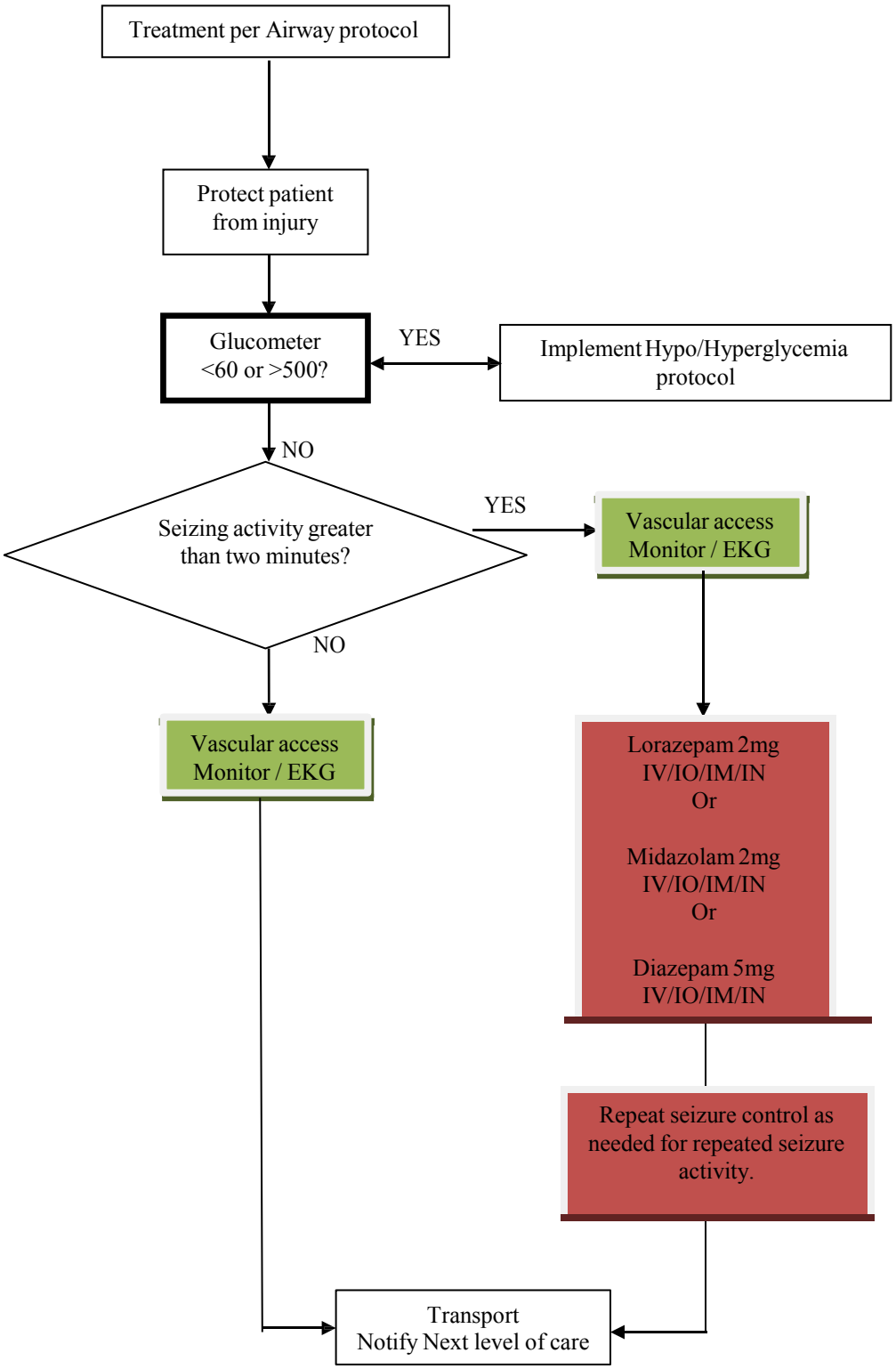
C. Warnings/Alerts:

1) Ativan, Valium, and Versed all have the potential to cause respiratory depression and bradycardia. Patients shall have continuous cardiac and SpO_2 monitoring.

2) Flush IV lines thoroughly after Valium administration. Valium is incompatible with most other medications.

3) After two attempts of controlling a seizure, seizure activity continuing, implement RSI protocol.

Seizures


Treatment per Airway protocol
Protect patient from injury
Glucometer <60 or >500?
YES
Implement Hypo/Hyperglycemia protocol
NO
Seizing activity greater than two minutes?
YES
Vascular access Monitor / EKG
NO
Vascular access Monitor / EKG
Lorazepam 2mg IV/IO/IM/IN Or
Midazolam 2mg IV/IO/IM/IN Or
Diazepam 5mg IV/IO/IM/IN
Repeat seizure control as needed for repeated seizure activity.
Transport Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

28. ***Shock***

A. Objectives:

1) To assess and treat patients with tissue perfusion.

B. General Information:

1) Types of shock:
- Hypovolemic: Hemorrhage / Fluid loss
- Cardiogenic (Pump failure)
- Distributive (Sepsis)
- Obstructive (Tension Pneumo)

2) All patients being treated for shock shall be given a blanket or hypothermia prevention kit.

3) Optimize Hemostasis: Fluid resuscitation in;

- Hemorrhagic trauma with NO significant head injury should follow permissive hypotensive resuscitation guidelines (PHRG) maintaining MAP 60, but not raising the BP into the "normal" range, which may increase bleeding. Only give minimal "bolus" appropriate resultative fluid per JTS CPG to **maintain MAP >60, NIBP Systolic BP >90 , palpable Radial pulse (Femoral pulse preferred), (if NIRS device available, STO_2 >70%) and/or change in mental status.**

- Hemorrhagic trauma WITH significant head injury should NOT follow permissive hypotension guidelines. **Maintain NIBP Systolic BP 110><160 and MAP 80><110.**

- Calcium shall be administered on all trauma patients with suspected internal bleeding or hypovolemic shock, as is directly helps with clotting factors. This may be given in conjunction with TXA and blood products, however if only one IV/IO access is present do not delay the administration of blood products.

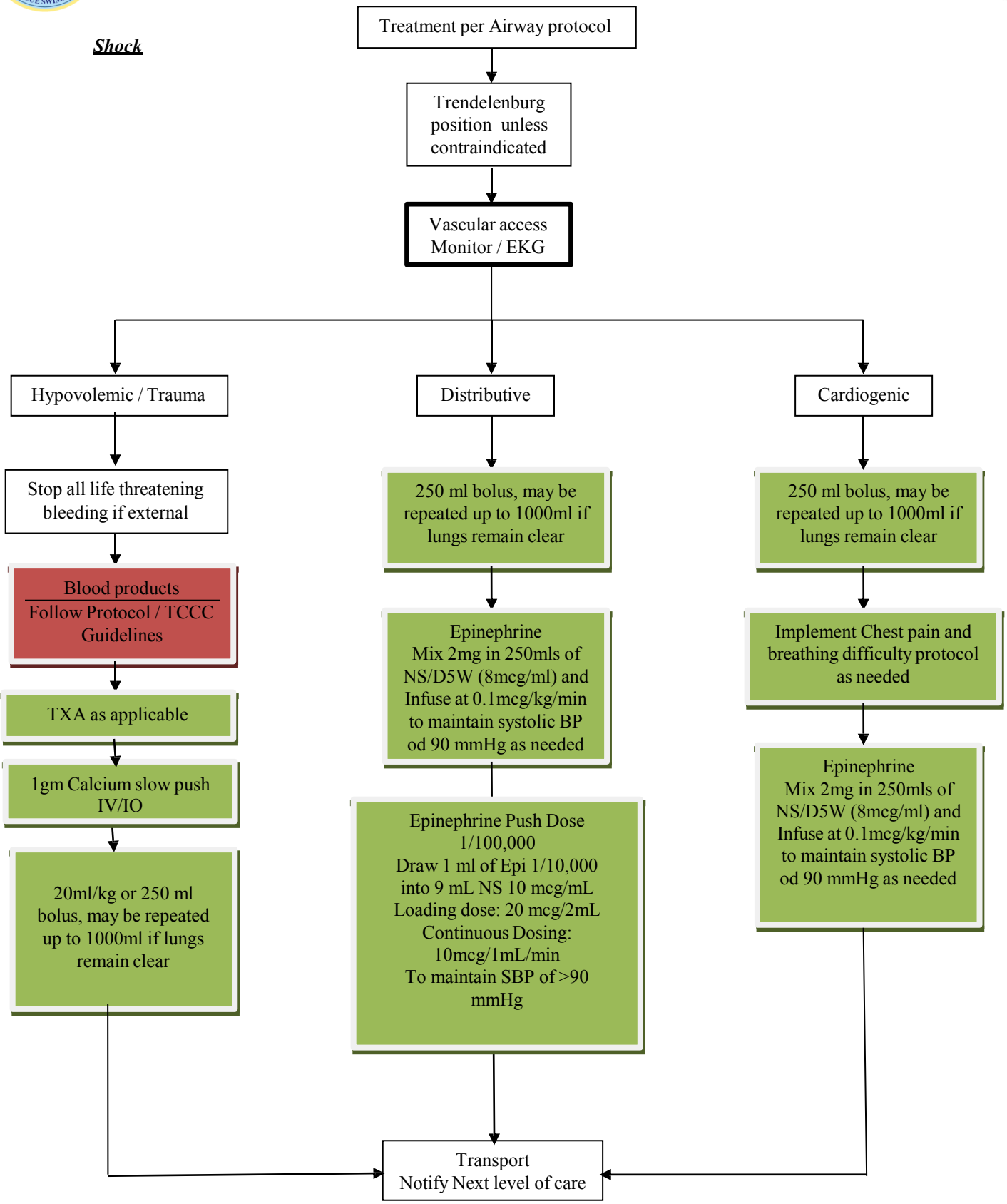
C. Warnings/Alerts:

1) Avoid Pressors as able (use as LAST RESORT in TRAUMA) – Always continue IVFs: Optimize hemostasis and correct volume loss.

D. Notes:

1) The goal of hypovolemic shock management is to prevent the lethal triad of hypothermia, acidosis, and coagulopathy.

Shock


Treatment per Airway protocol
Trendelenburg position unless contraindicated
Vascular access Monitor / EKG
Hypovolemic / Trauma
Distributive
Cardiogenic
Stop all life threatening bleeding if external
Blood products
Follow Protocol / TCCC Guidelines
TXA as applicable
1gm Calcium slow push IV/IO
20ml/kg or 250 ml bolus, may be repeated up to 1000ml if lungs remain clear
250 ml bolus, may be repeated up to 1000ml if lungs remain clear
Epinephrine
Mix 2mg in 250mls of NS/D5W (8mcg/ml) and Infuse at 0.1mcg/kg/min to maintain systolic BP od 90 mmHg as needed
Epinephrine Push Dose 1/100,000
Draw 1 ml of Epi 1/10,000 into 9 mL NS 10 mcg/mL
Loading dose: 20 mcg/2mL
Continuous Dosing: 10mcg/1mL/min
To maintain SBP of >90 mmHg
250 ml bolus, may be repeated up to 1000ml if lungs remain clear
Implement Chest pain and breathing difficulty protocol as needed
Epinephrine
Mix 2mg in 250mls of NS/D5W (8mcg/ml) and Infuse at 0.1mcg/kg/min to maintain systolic BP od 90 mmHg as needed
Transport
Notify Next level of care

III. ADULT PATIENT CARE PROTOCOLS

29. ***Needle Chest Decompression/Thoracostomy-finger or tube***

A. Objectives:

1) To provide guidance for how and when providers should perform needle decompression.

2) Insertion of a chest tube is an advanced level practice to be performed only by those providers certified as FP-C, TP-C, or RN and above.

B. General Information:

1) Management of Tension Pneumothorax and or Massive Hemothorax requires chest decompression.

2) Needle decompression is the primary relief of a Tension Pneumothorax pre-hospital.
- Midclavicular – 2nd intercostal space
- Anterior axillary – 5th intercostal space

3) After needle decompression a chest seal or occlusive dressing shall be placed over site to prevent sucking chest wound.

4) If needle decompression is ineffective, prolonged transport time or distance expected, or in the presence of massive barotrauma, a chest tube or finger thoracostomy may be the most effective for maintaining chest decompression.
- Incision site: Affected side, anterior axillary- 5th intercostal space

5) Consider pain management/sedation prior to procedure. Do not delay treatment for sedation.

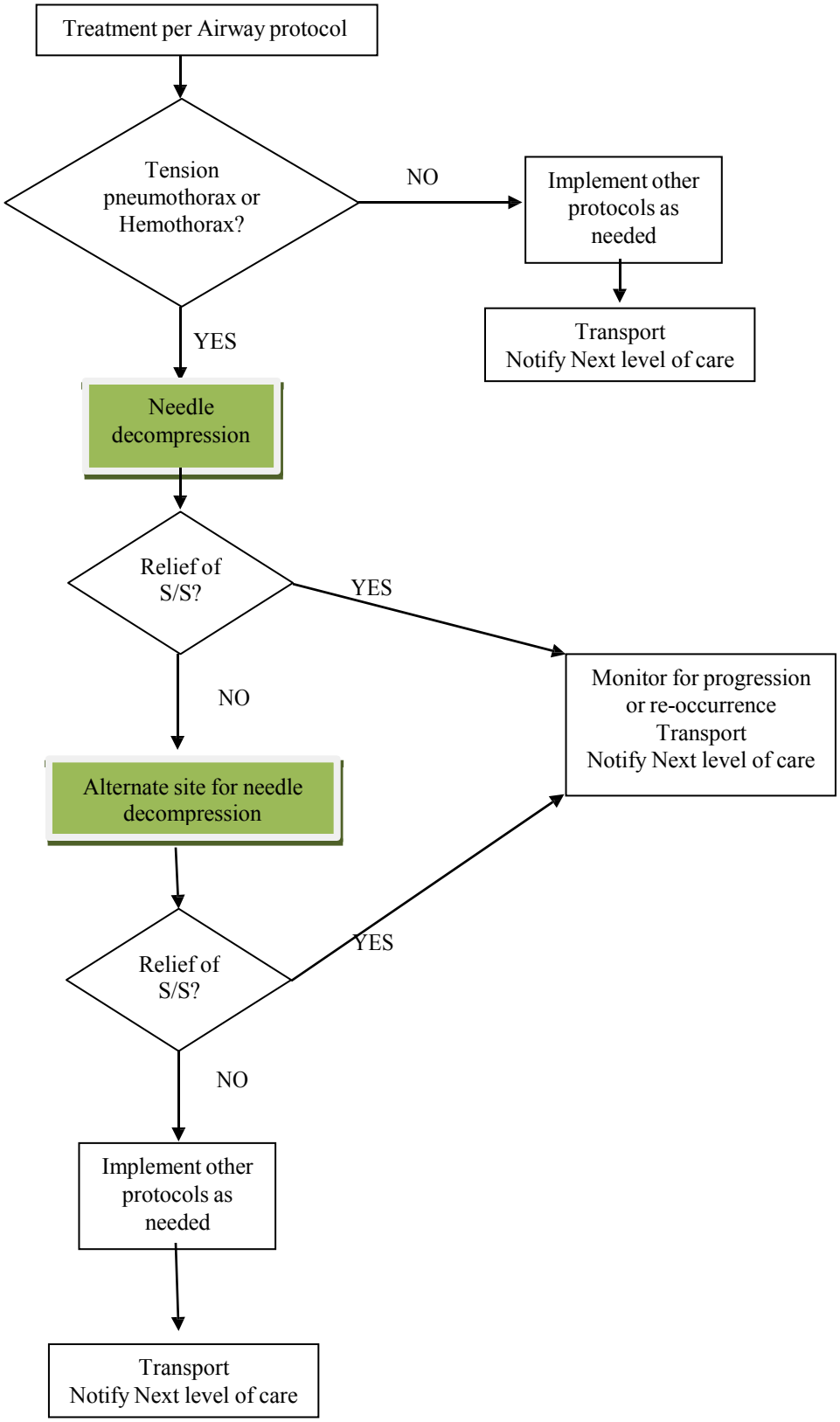
C. Warnings/Alerts:

1) Larger patients may require multiple needle decompressions or alternate anterior axillary site.

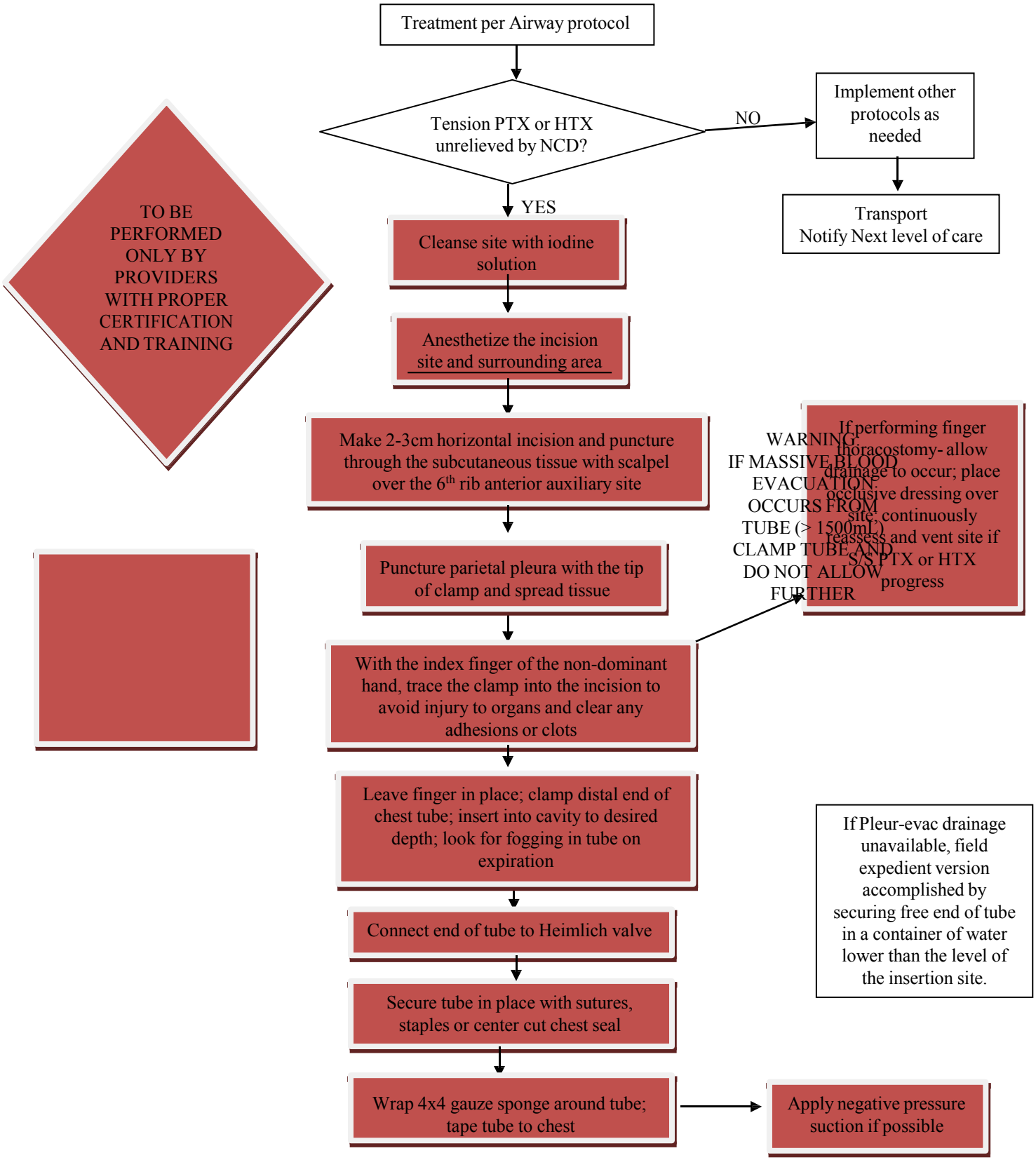
2) Do not insert any needle/tube/finger medial to the Anterior axillary line as there is risk to damage the great vessels and impact the myocardium.

3) Avoid Needle decompression in patients that are hemodynamically stable.

Needle Chest Decompression



Chest Tube Insertion/Finger Thoracostomy


Treatment per Airway protocol
Tension PTX or HTX unrelieved by NCD?
NO
Implement other protocols as needed
Transport
Notify Next level of care
YES
TO BE PERFORMED ONLY BY PROVIDERS WITH PROPER CERTIFICATION AND TRAINING
Cleanse site with iodine solution
Anesthetize the incision site and surrounding area
Make 2-3cm horizontal incision and puncture through the subcutaneous tissue with scalpel over the 6th rib anterior auxiliary site
Puncture parietal pleura with the tip of clamp and spread tissue
With the index finger of the non-dominant hand, trace the clamp into the incision to avoid injury to organs and clear any adhesions or clots
WARNING:
IF MASSIVE BLOOD EVACUATION OCCURS FROM TUBE (> 1500mL) CLAMP TUBE AND DO NOT ALLOW FURTHER
If performing finger thoracostomy- allow drainage to occur; place occlusive dressing over site; continuously reassess and vent site if S/S PTX or HTX progress
Leave finger in place; clamp distal end of chest tube; insert into cavity to desired depth; look for fogging in tube on expiration
Connect end of tube to Heimlich valve
Secure tube in place with sutures, staples or center cut chest seal
Wrap 4x4 gauze sponge around tube; tape tube to chest
Apply negative pressure suction if possible
If Pleur-evac drainage unavailable, field expedient version accomplished by securing free end of tube in a container of water lower than the level of the insertion site.

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III. ADULT PATIENT CARE PROTOCOLS

30. *Toxicological Emergencies (Overdose)*

A. Objectives:

1) To assess and treat patients who have a toxicological medical emergency.

B. General Information:

1) CNS depressants (Symptoms may include: respiratory depression, pinpoint pupils, bradycardia, and hypotension)
- Examples: Opiates, Benzodiazepines, Ethyl Alcohol

2) Hallucinogens (Symptoms may include: Hallucinations, Hypertension, and Tachycardia)
- Examples: LSD, Cannabis, PCP, Mushrooms, Ecstasy, Jimson Weed, Spice, Nutmeg

3) CNS stimulants (Symptoms may include: Hypertension, tachycardia, dysrhythmias)
- Examples: Cocaine, amphetamines, methamphetamines, Dexedrine, caffeine, ephedrine

4) Tricyclic Antidepressants (Symptoms may include: Altered mental status, seizure, depressed respirations, and coma)
- Examples: Amitrptyline (Elavil), Amoxapine (Asendin), Flexeril (Cyclobenzaprine), Imipramine (Trofanil), etc…

C. Warnings/Alerts:

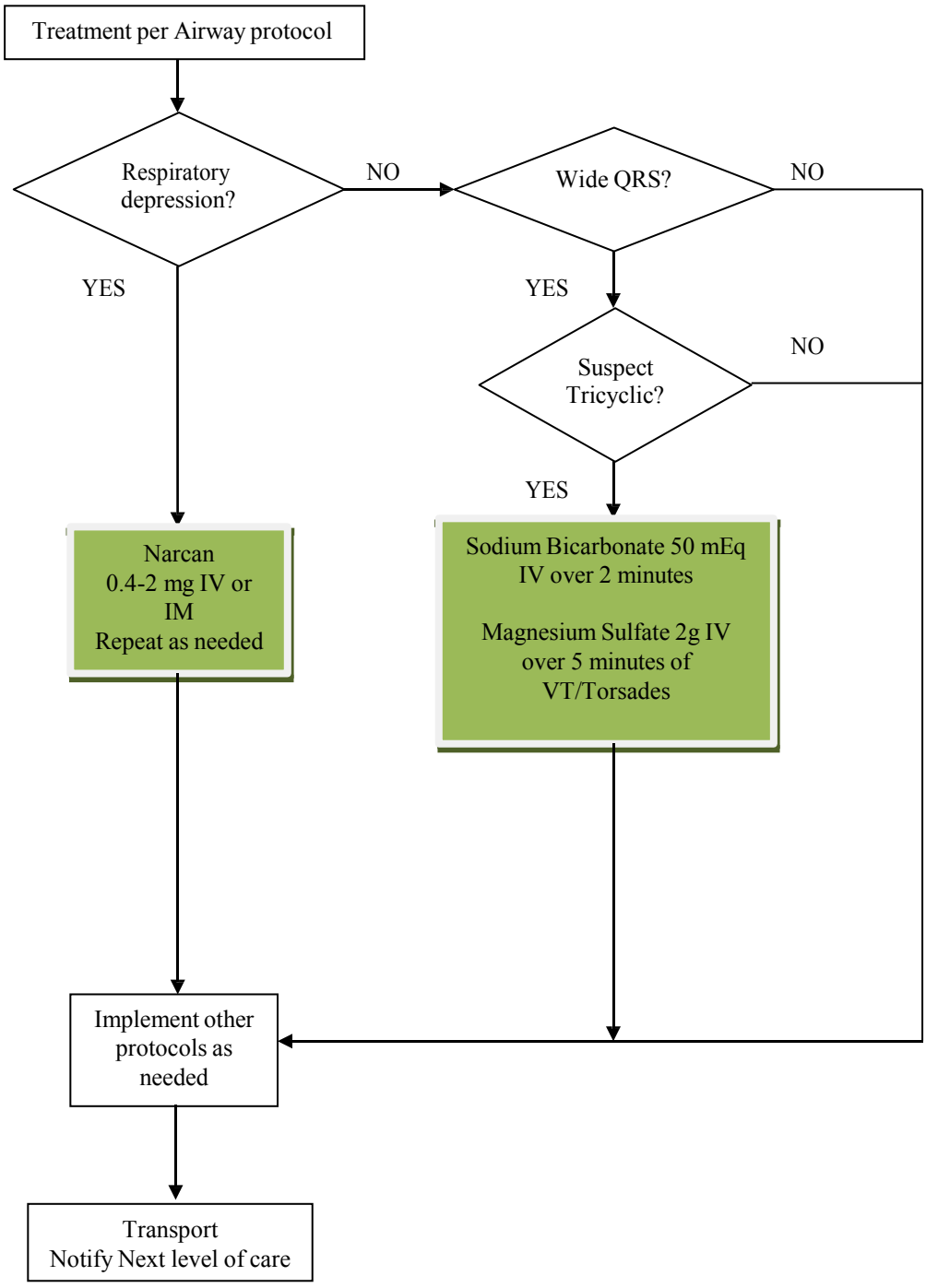
1) Narcan can precipitate seizures in patients with seizure HX or in long term narcotic addicts.

2) The goal of Narcan is to establish adequate respiratory rate and drive, not to return the patient to full consciousness.

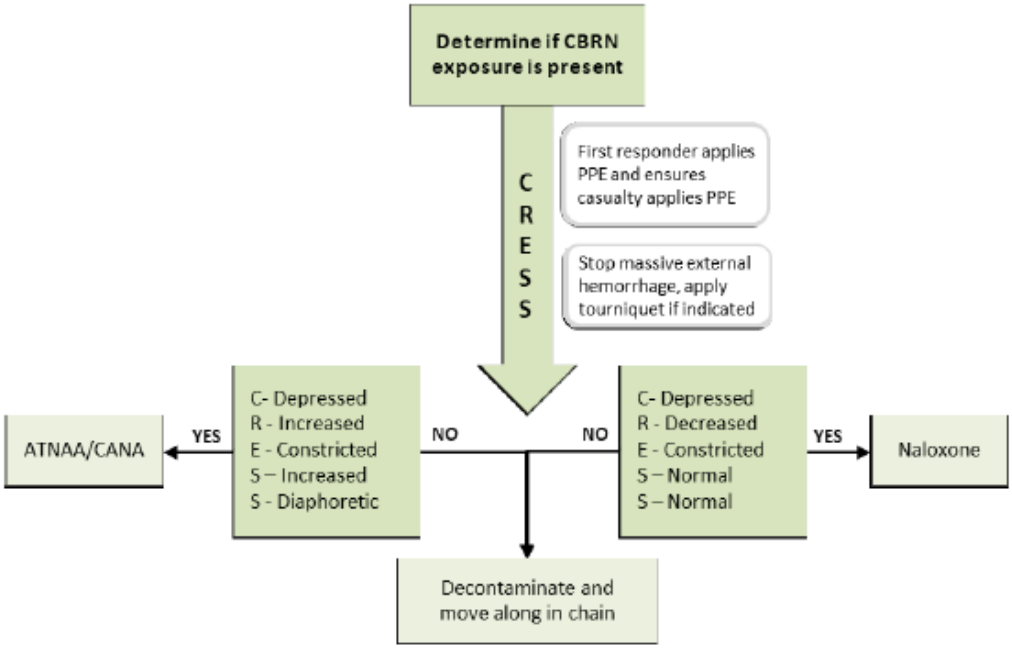
3) Narcan has a short half-life and may need to be repeatedly dosed until transfer of care is complete.

4) If at all possible, documentation or collection of medications suspected to be used by the patient should be transported.

Toxicological Emergencies (Overdose)



C	Consciousness (unconscious, seizures, depressed consciousness, agitation)
R	Respirations (present or absent, labored, increased or decreased)
E	Eyes (constricted, dilated, normal)
S	Secretions (dry, normal, increased)
S	Skin (diaphoretic, dry, hot, cyanosis)



Nerve agents: The signs and symptoms of nerve agent poisoning will depend on the dose and route of the exposure. In general, larger doses and direct inhalation of nerve agent vapor result in quicker onset and greater severity of effects. The most important effects of nerve agents are on the lungs, airway and the nervous system. Nerve agents exert their toxic effects by inhibiting or blocking the action of acetylcholinesterase (AChE), a critical enzyme. AChE is found in the plasma, red blood cells and nervous tissue. Although nerve agents will affect the enzyme in all three areas, it is the neurological effects which are the most important.

The mnemonic SLUDGE helps identify some of these findings:

- Salivation
- Lacrimation
- Urination
- Defecation
- Gastric
- Emptying

Key Measures in Resuscitating Nerve Agent Patients
• Secure the airway and provide positive pressure ventilation
• Administer atropine and 2-Pam-Chloride
• Administer Valium if supplied. Otherwise utilize Versed.
• Repeat atropine as needed

III. ADULT PATIENT CARE PROTOCOLS

31. *Trauma / Traumatic Arrest*

A. Objectives:

1) To appropriately assess and treat patients who have traumatic injuries.

B. General Information:

1) Control all life-threatening bleeding
- Direct pressure / wound packing
- If direct pressure does not work, Tourniquet if appropriate

2) Lifesaving interventions that may be performed pre-transport:
- Control of all Arterial or massive bleeding
- Emergency Cricothyroidotomy of an Obstructed Airway
- Needle decompression or Chest tube relief of a Tension Pneumothorax or massive Hemothorax. Chest tubes are indicated for long transports or no relief from needle decompressions.
- Stabilization of Pelvic injury with use of Pelvic sling device
- Management of a Flail Chest- positive pressure support or if indicated, Intubate and assist in ventilations as needed.

3) The goal of IV fluid administration is to maintain a systolic BP of >90 mmHg. Should be practiced with caution in cases of abdominal injuries.

4) For patients with head injuries and a GCS < 8, the goal of IV fluid administration is to maintain a systolic BP of >110 mmHg and establish a secure airway.

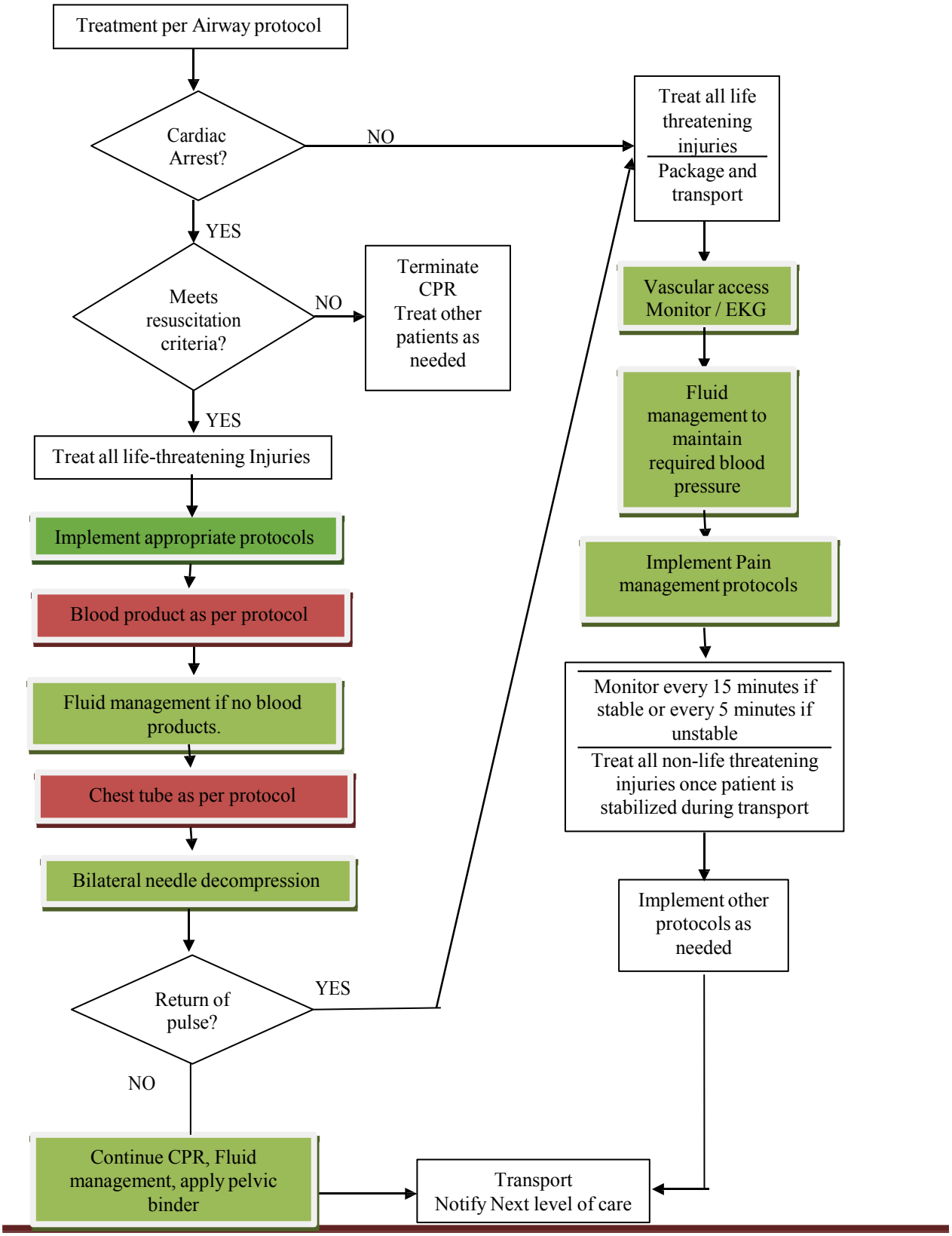
5) Trauma resuscitation Criteria:
- Should be discontinued if injuries are incompatible with life (rigor mortis, lividity, etc.)
- Mass casualty situation, patients with no breathing and pulse shall follow START algorithm.

6) All treatments to Trauma patients shall be in accordance with International Trauma Life Support guidelines (ITLS), Pre-Hospital Trauma Life Support (PHTLS), Tactical Combat Casualty Care Guidelines (TCCC), and/or Clinical Practice Guidelines (CPG's).

C. Warnings/Alerts:

1) Do not delay transport to perform NON-lifesaving interventions on scene.

Trauma / Traumatic Arrest



III. ADULT PATIENT CARE PROTOCOLS

32. *Vascular Access*

A. Objectives

1) To provide guidance for how and when providers should obtain vascular access.

B. General Information:

1) Fluid management standing orders for hyperprofusion:
- Adults: 250mL bolus with reassessment up to 1000mL

2) All bolus medications shall be followed by an appropriate flush, 20-30ml.

3) Site selection for peripheral access shall start distally in the extremities.

4) Indications for Intraosseous access:
- Cardiac arrest
- Profound hypovolemia
- Patients's with immediate need for medications or fluids.

5) IO's shall be flushed prior to administering any fluid/medications into the site.

6) IO approved sites:
- Sternal (F.A.S.T 1 Device only)
- Proximal Tibia – 1-2 finger width medial to the tuberosity
- Proximal Humerus – Directly in the greater tubercle (Lateral, upper aspect of the humerus)

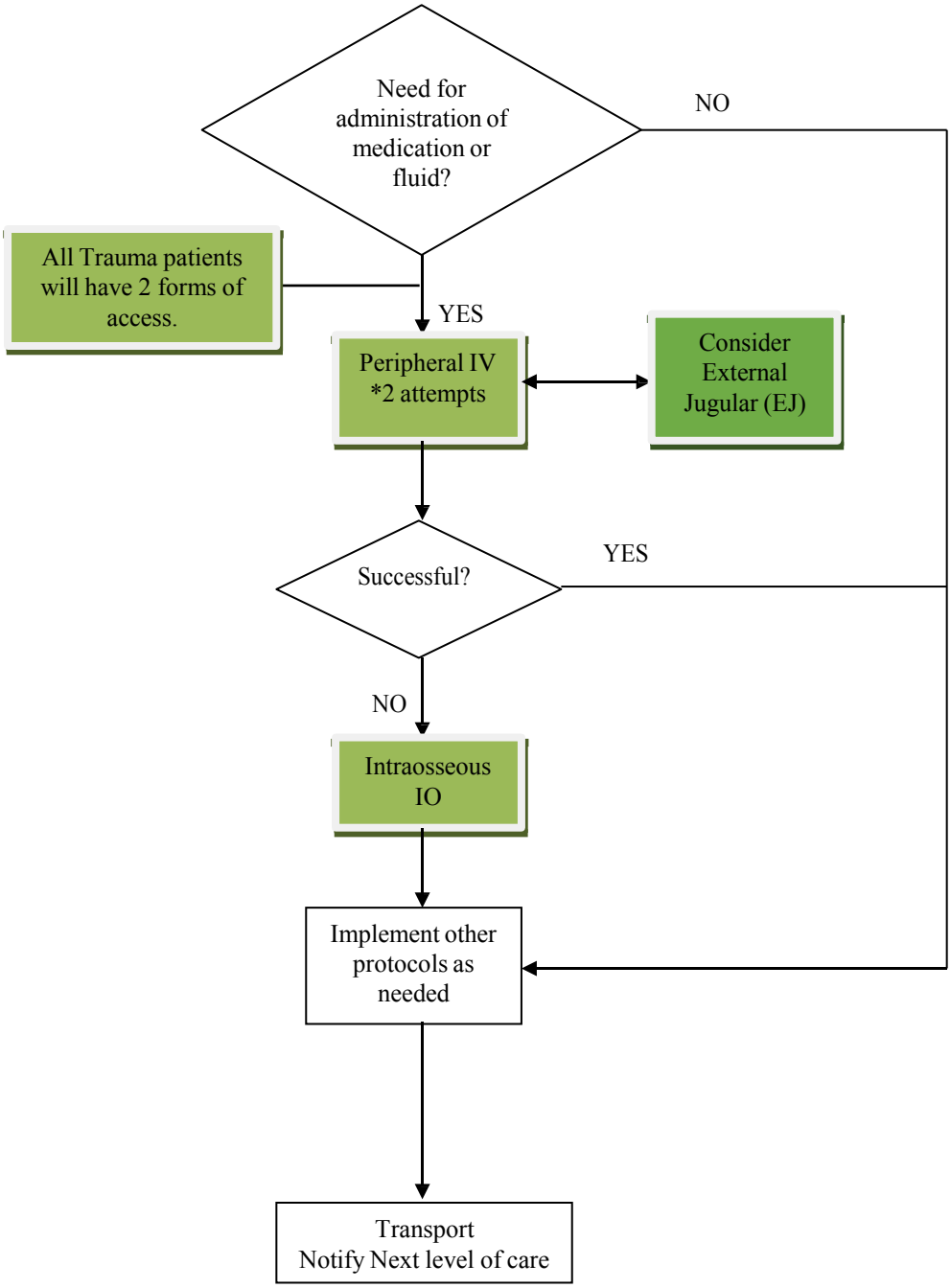
C. Warnings/Alerts:

1) Do not use a 14g or above needle for IV use.

2) Failure to properly flush after administration of an IO will result in poor or occluded flow.

3) Caution in placement of External Jugular (EJ) due to increased improper placement.

Vascular Access



III. ADULT PATIENT CARE PROTOCOLS

33. ***Ventilator Management***

VENTILATOR MANAGMENT

CLINICAL INDICATIONS:

- Patient received from transferring facility, intubated, and requires ventilator support.
- Patient requiring intubation in the field and subsequent respiratory support.

CONTRAINDICATIONS:

- Equipment malfunction / failure.

PROCEDURE:

- Turn on ventilator and ensure that machine is functional and battery is charged.
- Attach ventilator tubing and O_2 tubing to machine.
- If patient is a transfer and already on vent, maintain ventilator settings from medical treatment facility.
- **If patient "newly" on ventilator, initial settings should include:**
  - **Mode: AC, SIMV, or ASV (if using Hamilton T1)**
  - **Rate: 10-16bpm (or adequate rate for pediatric patient)** (typical adult start rate is 12, then adjust PRN)
  - **FiO_2: 100 percent**
  - **I:E ratio: 1:2 – 1:4**
  - **Tidal Volume: 6-8mL/kg (of ideal body weight)**
  - **PEEP: 5**
- Monitor waveform on machine and patient to ensure not "breathe stacking" – if this occurs, a high-pressure alarm may sound. However, if breath stacking suspected even in absence of alarm – disconnect tubing and allow exhalation. Increase I:E.
- If at any time patient begins to desaturate or develop respiratory problems – check rapidly to ensure that vent did not fail and O_2 tank not empty. Immediately disconnect ventilator and ventilate patient with BVM and 100% O_2. If this resolves problem or vent failed, continue to bag patient. Then titrate FiO_2 down as much as possible while keeping O_2 sat >93% (Goal FiO_2 50-60%) in order to attempt to conserve oxygen for long flights and conserve battery power.
- If problem does not resolve, ensure tube did not move during transfer. If advanced – pull back to original length and attempt to bag. If this fails, ensure equal chest rise with breaths and that a tension pneumothorax has not developed (if chest tube in place, ensure it is functioning). If tension pneumothorax suspected, perform immediate needle thoracostomy.
- If tube has pulled farther out of trachea, DO NOT ATTEMPT TO ADVANCE IT without placement of bougie to verify tracheal placement. When advancing bougie to verify placement, feel for tracheal rings or carina stop. If in doubt, pull tube and attempt BVM. If this fixes problem, continue to bag patient.

Document procedure, results, and vital signs.

Ventilator Management

VENTILATOR Capabilities, Terms, Transfer Procedure, Troubleshooting

Ventilator Capabilities

Impact Model 754 Ventilator
A/C
SIMV
CPAP
Volume Control

Impact Uni-Vent 731 Series EMV+
A/C
SIMV
CPAP
Volume Control
Pressure Control
Pressure Support

Simplified Automated Ventilator (SAVe)
Single tidal volume and respiratory rate (Vt = 600 mL; BPM 10)
6 Lpm of supplemental O_2 (MAX FiO_2 = 62%)

SAVEe II
Varied tidal volume based on patient height
Accepts supplemental O_2 (FiO_2 21 – 100%)

AutoVent 3000
CMV
Adult / Child
Tidal volume
Inspiratory time
BPM

Versamed iVent201
A/C
SIMV
CPAP
Pressure support ventilation (PSV)

Hamilton T1
CMV, SIMV, PCV, DuoPAP, APRV, ASV
Adult / Child

Terms

Volume-targeted modes (Examples: CMV, A/C, SIMV): Volume constant, inspiration terminates when preset V_t delivered. Peak airway pressure is variable and increases as needed to deliver prescribed V_t.

Pressure-targeted modes (Examples: PSV, PCV): Volume variable, terminates when preset pressure reached. Volume is variable. Peak airway pressure is fixed, determined by set pressure level.

Adaptive Support Ventilation (ASV): Only available on the Hamilton T1. ASV provides intelligent ventilation mode that continuously adjusts respiratory rate, tidal volume, and inspiratory time depending on the patient's lung mechanics and effort.

Tidal volume (V_t): The volume of gas, either inhaled or exhaled, during a breath and commonly expressed in milliliters. V_t is generally set between 6-10ml/kg IBW (ideal body weight), to prevent lung over-distension and barotrauma.

IBW calculation:
Men: [(height in inches – 60) x 2.2] + 50= Kg IBW
Women: [(height in inches – 60) x 2.2] + 45= Kg IBW

Ventilator Management

Minute Ventilation (V_E): The average volume of gas entering, or leaving, the lungs per minute, commonly expressed in liters per minute. The product of V_t and RR (respiratory rate). Normal V_E is 5 – 10 L/min.

Inspiratory (I) and Expiratory (E) time and I:E ratio: The speed at which the V_t is delivered. Setting a shorter inspiratory time (I) results in a faster inspiratory flow rate. Average adult I time is 0.7 to 1 second. I:E ratio is usually 1:2 to 1:4

Positive end-expiratory pressure (PEEP): The amount of positive pressure that is maintained at end-expiration. It is expressed in centimeters of water. The purpose of PEEP is to increase end-expiratory lung volume and reduce air-space closure at end-expiration. Normal Physiologic PEEP is 5cm/H_2O.

Peak flow rate or peak inspiratory flow: The highest flow, or speed, that is set to deliver the V_t during inspiration, usually measured in liters per minute. When the flow rate is set higher, the speed of gas delivery is faster and inspiratory time is shorter.

Peak Airway Pressure (P_{AW}): Represents the total pressure that is required to deliver the V_t and depends upon various airway resistance, lung compliance, and chest wall factors. It is expressed in centimeters of water (cm H_2O).

Sensitivity or trigger sensitivity: Effort, or negative pressure, required by the patient to trigger a machine breath, commonly set so that minimal effort (-1 to -2 cm H_2O) is required to trigger a breath.

Ventilator Transfer Procedure

1. Ensure endotracheal tube is secure, document size and position of ETT at the teeth.

2. Ventilator settings should be coordinated with the transferring physician, anesthesia provider or respiratory therapist. Verify settings, review arterial blood gas (ABG) analysis, and current SPO_2 and $ETCO_2$ readings.

3. ABG should be done within 30 minutes of flight. If time allows, patient should be on transport ventilator for at least 15 minutes prior to transport.

4. The initial tidal volume (V_t) 6 – 10 mL/kg ideal body weight (IBW).

5. Pressure Support: If patient has a spontaneous tidal volume, titrate Pressure Support setting to maintain tidal volume minimum of 4-5 ml/kg, typically 10 cmH_2O.

6. Respiratory rate (RR) should be set to administer a minute ventilation (V_E) of 5 –10 L/min. Maintain $ETCO_2$ between 30-40 mm/Hg. [Current $ETCO_2$ × Current RR ÷ desired $ETCO_2$ = new respiratory rate]

7. PEEP 2-10 cm H_2O

8. I:E Ratio = 1:2 or 1:3

9. FiO_2: Initiate at 100% and titrate FiO_2 to maintain SpO_2 >94%. Wean patient to the lowest level of FiO_2 and PEEP while maintaining SpO_2 >94%. Goal is FiO_2 50-60 and SpO_2 >94%.

Troubleshooting: Airway compromise or lost airway in-flight

Remove patient from circuit and perform bag-valve ventilation with 100% O_2 while troubleshooting (check to ensure patient can fully exhale first in case there was air trapping).

- **DOPE**: Displaced ETT / Obstructed ETT / Pneumothorax / Equipment failure

Ventilator Management

- If at any time patient begins to desaturate or develop respiratory problems, immediately disconnect ventilator and ventilate patient with BVM (with PEEP valve if available) and 100% O_2 while correcting issues utilizing the D.O.P.E. algorithm:
    - Displacement: ETT in place, patient not extubated/ tube did not move during transfer. If advanced – pull back to original length and attempt to bag; if tube has pulled farther out of trachea, DO NOT ATTEMPT TO ADVANCE IT without placement of bougie to verify tracheal placement. When advancing bougie, feel for tracheal rings or carina stop. If in doubt, pull tube and attempt BVM. If this fixes problem, continue to bag patient. Upon stabilization, consider alternative advanced airways (extraglotic airway or cric).

      **If ETT moves freely, access for ETT bulb rupture.
    - Obstructions: Assess for secretions in ETT. Suction if indicated.
    - Pressure: Ensure that a tension pneumothorax / hemothorax has not developed (if chest tube in place, ensure it is functioning/ not kinked or clamped). If tension pneumo/hemothorax suspected, perform immediate needle thoracostomy. Assess the need for escarotomy if circumferential burn. Consider additional paralysis and sedation if patient does not tolerate ventilation.
    - Equipment: Ensure that vent did not fail; O_2 tank not empty. If ventilator is operational, trace all tubes to the patient connection (airway tube, transducer line, exhalation line) ensuring patency and connections.

- **Airway**: Confirm ETT is in appropriate position: look / feel for symmetric chest wall rise and verify tube position Check $ETCO_2$
- Suction ETT if suspected secretion obstruction
- **Breathing**: Look and feel for chest excursion, check SPO_2, check patient's color; Assess for pneumothorax
- **Circulation**: check pulse, BP, and cardiac rhythm
- Assess for equipment failure (e.g., battery, depleted oxygen, vent settings)

Note: Remember, PCO_2 is affected by respiratory rate and tidal volume (ventilation), while PO_2 is affected by PEEP and FiO_2 (oxygenation).

10. **High pressure alarms / Peak airway pressure alarms** (Peak pressure >35 cm H_2O): Correct problems causing increased airway resistance and decreased lung compliance, including pneumothorax or pulmonary edema. Check ventilator to make sure prescribed tidal volume is being delivered.

11. **Air leaks causing low pressure alarms / volume loss**: Assess, correct air leaks in endotracheal tube, tracheostomy cuff, ventilator system; recheck ventilator to make sure prescribed tidal volume is delivered.

12. **Ventilator dyssynchrony**: Agitation and respiratory distress that develop in a patient on a mechanical ventilator who has previously appeared comfortable represents an important clinical circumstance that requires a thorough assessment and an organized approach. The patient should not always be automatically re-sedated, but must instead be evaluated for several potentially life-threatening developments that can present in this fashion.

13. **Lung hyperinflation (air trapping) and auto-PEEP:** Dynamic hyperinflation is associated with positive end-expiratory alveolar pressure, or auto-PEEP. The physiologic effects include decreased cardiac preload because of diminished venous return into the chest. The reduced cardiac output that results from the reduction in preload can lead to hypotension and, if severe, to Pulseless Electrical Activity and cardiac arrest. Dynamic hyperinflation can also lead to local alveolar over-distention and rupture. Prevent, manage lung hyperinflation by decreasing tidal volume, changing inspiratory and expiratory phase parameters, switching to another mode, and correcting physiological abnormalities that increase airway resistance.

III. ADULT PATIENT CARE PROTOCOLS

34. *Determination of Death*

1. GENERAL PROVISIONS:

A. Purpose: The purpose of this policy is to assist SMTs in the determination of death in the field (i.e. pre-hospital setting). This policy is intended to provide SMTs with parameters to be used when determining whether or not to withhold resuscitative efforts and to provide guidelines for the Flight Surgeon for discontinuing resuscitative efforts.

B. Principles:

1) Resuscitative efforts are of no benefit to patients whose physical condition precludes any possibility of successful resuscitation.

2) Shall determine death based on specific criteria set forth in this policy.

3) Cold water drowning, hypothermia and barbiturate ingestion all prolong brain life and therefore treatment and transport should be considered on these patients.

4) The Unit's Flight Surgeon recognizes that SAR Medical Technicians have the discretion to initiate resuscitation in cases where the patient is obviously dead but a concern for unit morale exists. However, the SMT may decide to cease CPR once en route and or out of sight of concerned unit. Note: Given this situation, the SMT may perform CPR so long as:

a) The patient is not decapitated
b) No obvious decomposition (i.e. rigor) is present
c) Doing so does not put the provider and aircrew in danger

2. DEFINITIONS:

A. Obvious Death Criteria: A patient may be determined obviously dead by SAR Medical Technicians if, IN ADDITION to the absence of respiration, cardiac activity, and neurological reflexes, one or more of the following physical or circumstantial conditions exists:

1) Decapitation
2) Massive crush injury to the head, neck, or trunk
3) Penetrating or blunt injury with evisceration of the heart, lung or brain
4) Decomposition
5) Incineration
6) Rigor Mortis
7) Post-Mortem Lividity
8) Absence of vital signs (breathing, clear pulse, organized cardiac activity on a monitor)
9) Pupils fixed and dilated; absence of corneal reflex

B. Traumatic Cardiac Arrest: No pulse, no spontaneous respirations, no response to aggressive stimulation and pupils are fixed.

Determination of Death Cont'd.

A. Assessment: The Patient Assessment shall, at minimum, include the following items which must be documented on the patient's Patient Care Record (PCR):

1) Assure the patient has a patent airway;
2) Look, listen and feel for respirations; and
3) Check for a pulse for a minimum of 60 seconds.
4) Place patient on cardiac monitor (minimum of 3 leads)

B. Procedure:

1) Perform a Primary Assessment:

a. If patient meets obvious death criteria, do not proceed with resuscitation.
b. If a patient has been confirmed pulseless and apneic for at least 10 minutes (CPR having *not* been performed in that 10 minutes), do not proceed with resuscitation.

2) When not to initiate CPR:

a. Primary assessment reveals a pulseless, non-breathing patient who has signs of prolonged lifelessness in accordance with obvious death criteria.
b. A patient with an approved "Do-Not-Resuscitate" (DNR) document in accordance with Department policy.

C. Termination of CPR by SAR Medical Technicians:

1) Providers may discontinue resuscitative efforts as outlined below:

a. Any case in which information becomes available that would have prevented initiation of CPR had that information been available before CPR was initiated, CPR should be terminated.
b. If patient does not meet above criteria, initiate CPR. After 30 minutes of failure to respond to appropriate advanced life support treatment, defined as:

1) Establishment of airway
2) Sustained ventricular fibrillation or ventricular tachycardia with no pulse, despite attempts to defibrillate
3) Adequate medication therapy consistent with the patient's condition and rhythm
4) Successful thoracic needle decompression for trauma victims if indicated

c. If the treatment of one deteriorating patient would apparently lead to the further deterioration or loss of life of the other patient

2) Disposition of the decedent: If a determination of death has occurred and the decedent has not been moved from the original place of death:

a. The decedent shall remain at scene and not be transported:
b. Any treatment items, such as endotracheal tubes, intravenous catheters, ECG or defibrillation electrodes, shall be left in place;
c. Resuscitation equipment, such as bag-valve-mask devices ECG monitoring equipment, etc., may be removed from the deceased.

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IV. ***ADULT CARDIAC CARE PROTOCOLS***

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IV. ADULT CARDIAC CARE PROTOCOLS

1. ***Adult Cardiac Arrest***

A. Objectives

1) Early recognition and appropriate intervention of pulseless / apneic adult patients.

B. General Information

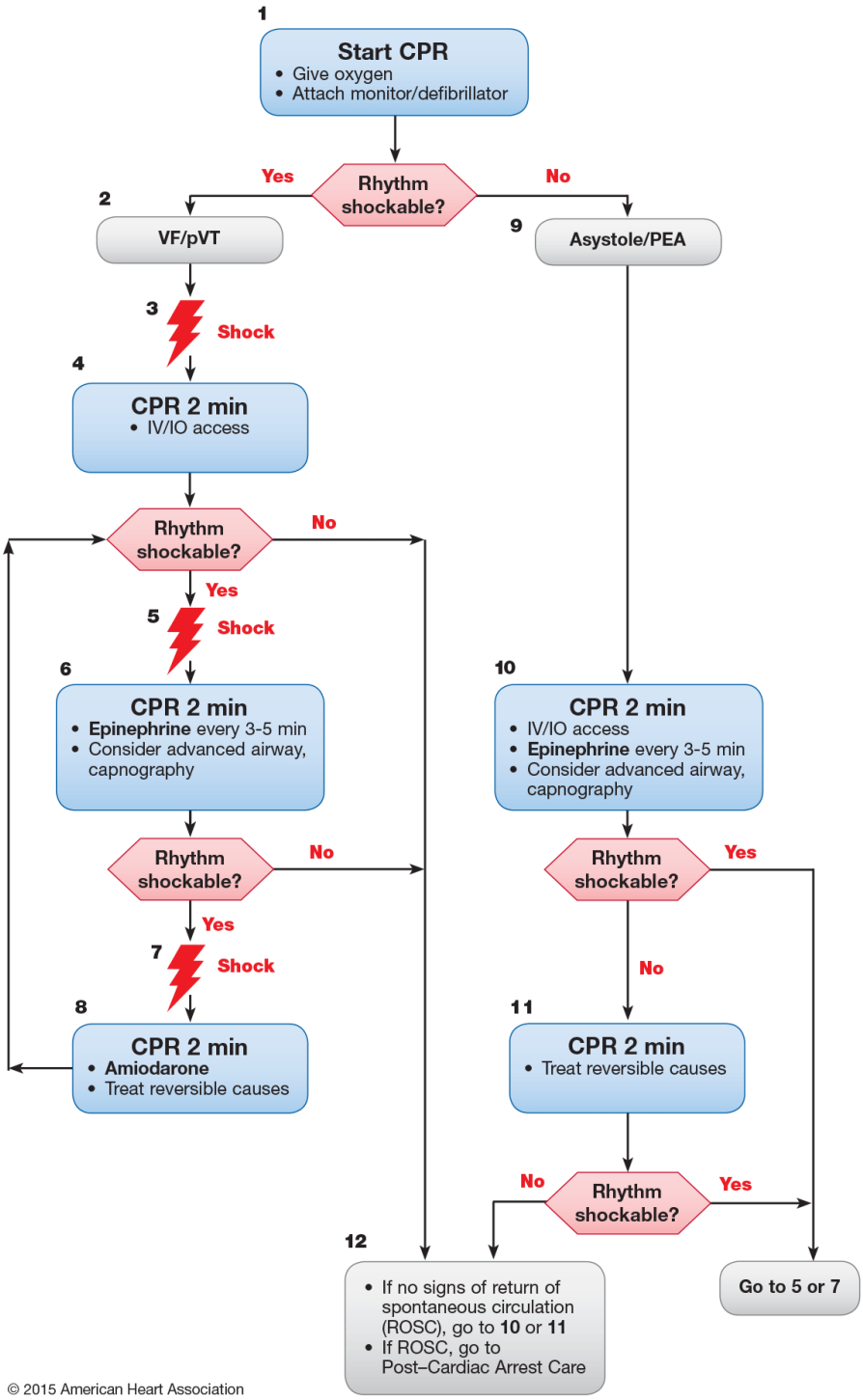
- Cardiopulmonary Resuscitation (CPR)
  a) CPR shall be given IAW 2015 American Heart Association Basic Life Support Guidelines
  b) Push hard and fast (at least 2 inches and at a rate of 100-120/Min)
  c) Ensure full chest recoil
  d) Minimize interruptions in compressions
  e) One cycle of CPR: 30 compressions then 2 breaths; 5 cycles-2min (If no Advanced Airway)
  f) Rotate compressors every 2 min if possible
  g) Check Rhythm every 2 min
  h) After advanced airway is placed, rescuers no longer deliver "cycles" of CPR
     1) Give continuous chest compressions without pauses for breaths
     2) Give 10 breaths/min
- Monitor / Defibrillator Use
  a) Follow appropriate protocol algorithm based on your rhythm analysis.
  b) Contraindications to defibrillation
     1) Rigor / Liver Mortis
     2) No Code / DNR situations
  c) If Patient successfully regains a pulse, maintain airway and ventilations as necessary and continue to monitor a pulse.

*If Patient becomes pulseless during transport, start CPR, and analyze rhythm.

C. Warnings / Alerts

- CPR may still be required in the presence of an organized cardiac rhythm.
- It is the responsibility of the provider delivering the shock to ensure that no one is touching the patient prior to shock delivery.
- Ensure that the patient is dried off and not laying in water prior to defibrillation.
- Ensure that transdermal medications are taken off and wiped clean prior to defibrillation.

Adult Cardiac Arrest Algorithm—2015 Update



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CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

2. ***Adult Asystole and Pulseless Electrical Activity***

A) Objectives:

1) Early recognition and appropriate intervention of pulseless / apneic adult patients.
2) Early appropriated recognition of lethal rhythms.

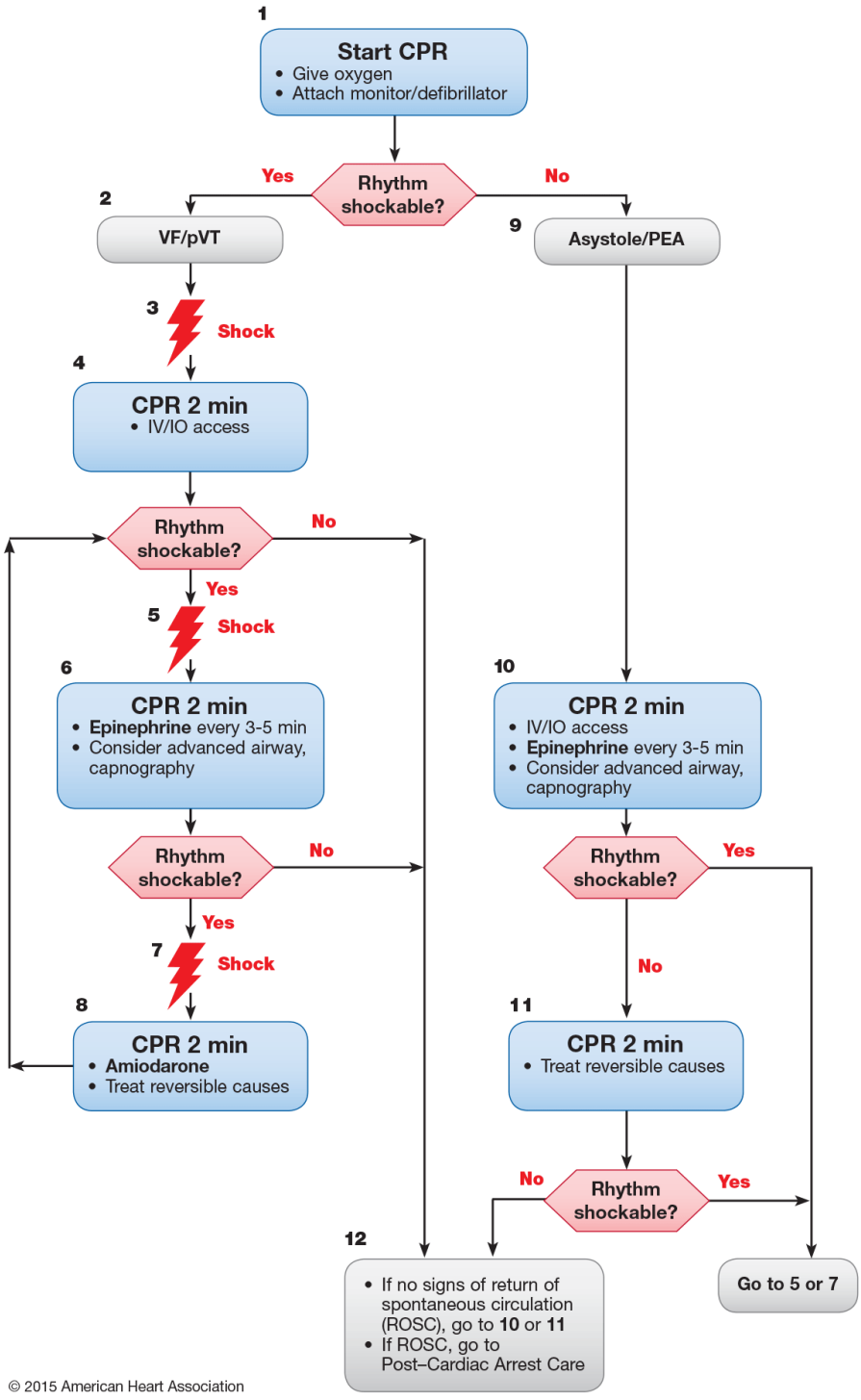
B) General Information:

- CPR shall be given IAW 2015 American Heart Association Basic Life Support Guidelines.
- Endotracheal administration of medications should be used ONLY when IV/IO access is not available.
- Search for and treat possible contributing factors using appropriate protocol for:
  - a) Hypovolemia
  - b) Hypoxia
  - c) Hypokalemia / Hyperkalemia
  - d) Hypoglycemia
  - e) Hypothermia / Hyperthermia
  - f) Hydrogen ion- (Acidosis)
  - g) Tension Pneumothorax
  - h) Toxins
  - i) Trauma
  - j) Tamponade Cardiac
  - k) Thrombosis (coronary or pulmonary)
- For cardiac arrest in renal patients administer Calcium Chloride 1 gm IV/IO push followed by 40 ml flush, Sodium Bicarbonate 1 Meq/kg and repeat in 10.

C) Warnings / Alerts

- CPR may still be required in the presence of an organized cardiac rhythm.

Adult Cardiac Arrest Algorithm—2015 Update



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CPR Quality

- Push hard (at least 2 inches [5 cm]) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 30:2 compression-ventilation ratio.
- Quantitative waveform capnography
  - If P_{ETCO_2} <10 mm Hg, attempt to improve CPR quality.
- Intra-arterial pressure
  - If relaxation phase (diastolic) pressure <20 mm Hg, attempt to improve CPR quality.

Shock Energy for Defibrillation

- **Biphasic:** Manufacturer recommendation (eg, initial dose of 120-200 J); if unknown, use maximum available. Second and subsequent doses should be equivalent, and higher doses may be considered.
- **Monophasic:** 360 J

Drug Therapy

- **Epinephrine IV/IO dose:** 1 mg every 3-5 minutes
- **Amiodarone IV/IO dose:** First dose: 300 mg bolus. Second dose: 150 mg.

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Abrupt sustained increase in P_{ETCO_2} (typically ≥40 mm Hg)
- Spontaneous arterial pressure waves with intra-arterial monitoring

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

3. ***Adult Bradycardia***

A) Objectives:

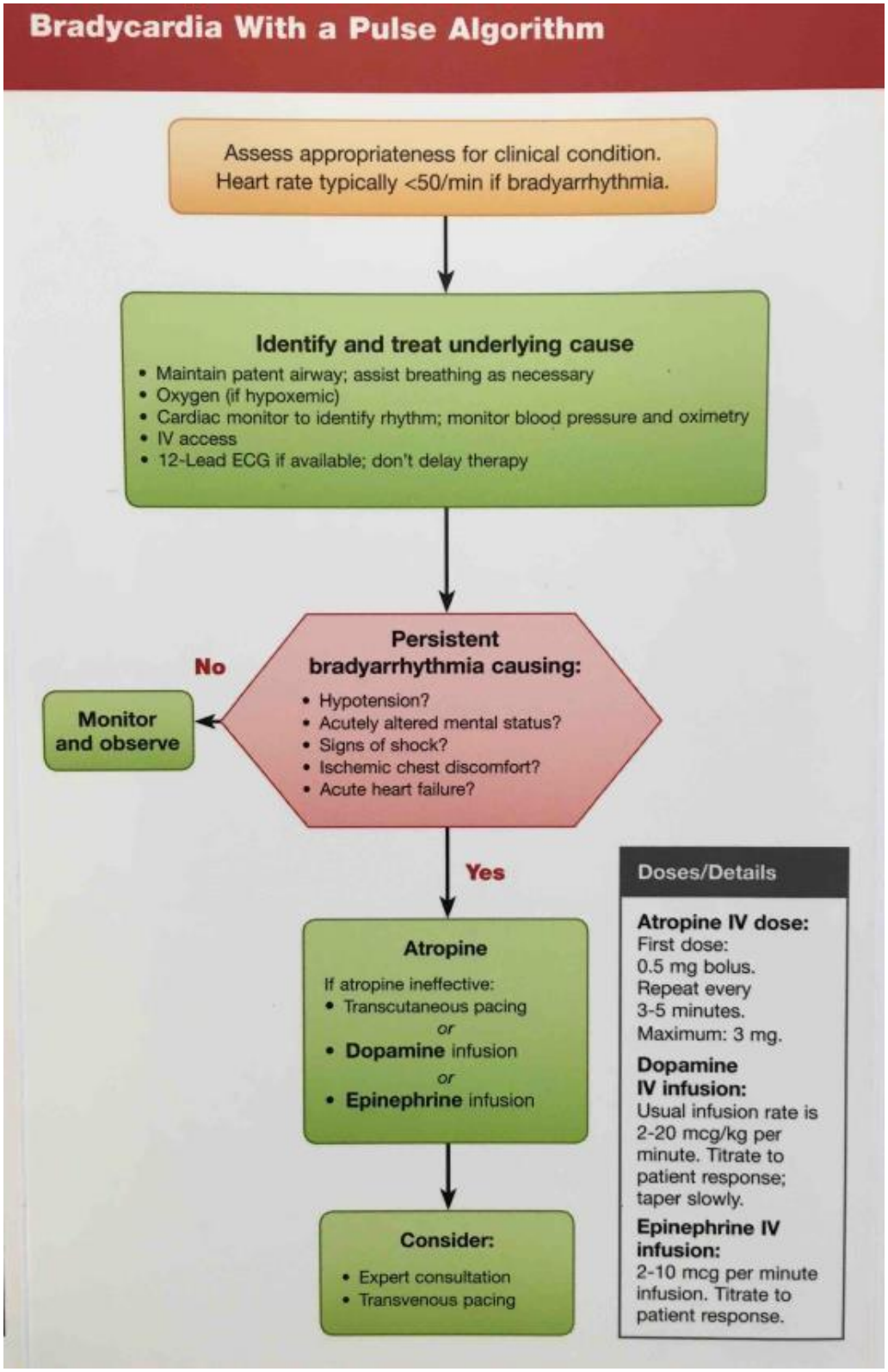
1) Early appropriate recognition and management of bradycardic rhythms.
2) Recognition of poor perfusion attributed to a bradycardic rhythm.

B) General Information:

- Signs and symptoms of poor perfusion include:
  a) New onset of altered mental status
  b) Ongoing chest pain
  c) Hypotension Systolic B/P less than 90. with associated signs and symptoms.
- If patient is stable, Atropine is first line medication.
- External Pacing
  a) Consider pain control and/or sedation
  b) Do not delay pacing for administration of medication
- Dopamine Drip
  a) Premixed Drip is preferred
  i) If not available then add 400 mg of Dopamine to 250 ml NS for concentration of 1600 mcg/ml
  b) Dose 2-10 mcg/kg/min
- Epinephrine Drip
  a) Add 0.4 mg of Epinephrine 1:1000 to 100 ml NS for a concentration of 4mcg/ml
  i) Dose 2-10 mcg/min
  b) Epinephrine Push Dose 1/100,000
  (i) Draw 1 ml of Epi 1/10,000 into 9 mL NS 10 mcg/mL
  Loading dose: 20 mcg/2mL
  Continuous Dosing: 10mcg/1mL/min
  To maintain SBP of >100 mmHg

C) Warnings/Alerts

- Patient may deteriorate due to unnecessary delay in pacing.
- Failure to recognize electrical and mechanical capture may lead to patient deterioration.
- Assessment of a carotid pulse may be inaccurate due to muscle jerking which may mimic a carotid pulse.
- Patients that are hypothermic should not be paced.
- Consider analgesia or sedation for pacing.


Bradycardia With a Pulse Algorithm
Assess appropriateness for clinical condition.
Heart rate typically <50/min if bradyarrhythmia.
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen (if hypoxemic)
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
• IV access
• 12-Lead ECG if available; don't delay therapy
Persistent bradyarrhythmia causing:
• Hypotension?
• Acutely altered mental status?
• Signs of shock?
• Ischemic chest discomfort?
• Acute heart failure?
No
Monitor and observe
Yes
Atropine
If atropine ineffective:
• Transcutaneous pacing
or
• Dopamine infusion
or
• Epinephrine infusion
Consider:
• Expert consultation
• Transvenous pacing
Doses/Details
Atropine IV dose:
First dose:
0.5 mg bolus.
Repeat every
3-5 minutes.
Maximum: 3 mg.
Dopamine IV infusion:
Usual infusion rate is 2-20 mcg/kg per minute. Titrate to patient response; taper slowly.
Epinephrine IV infusion:
2-10 mcg per minute infusion. Titrate to patient response.

IV. ADULT CARDIAC CARE PROTOCOLS

4 Cont. ***Adult Tachycardia- Narrow***

A) Objectives:

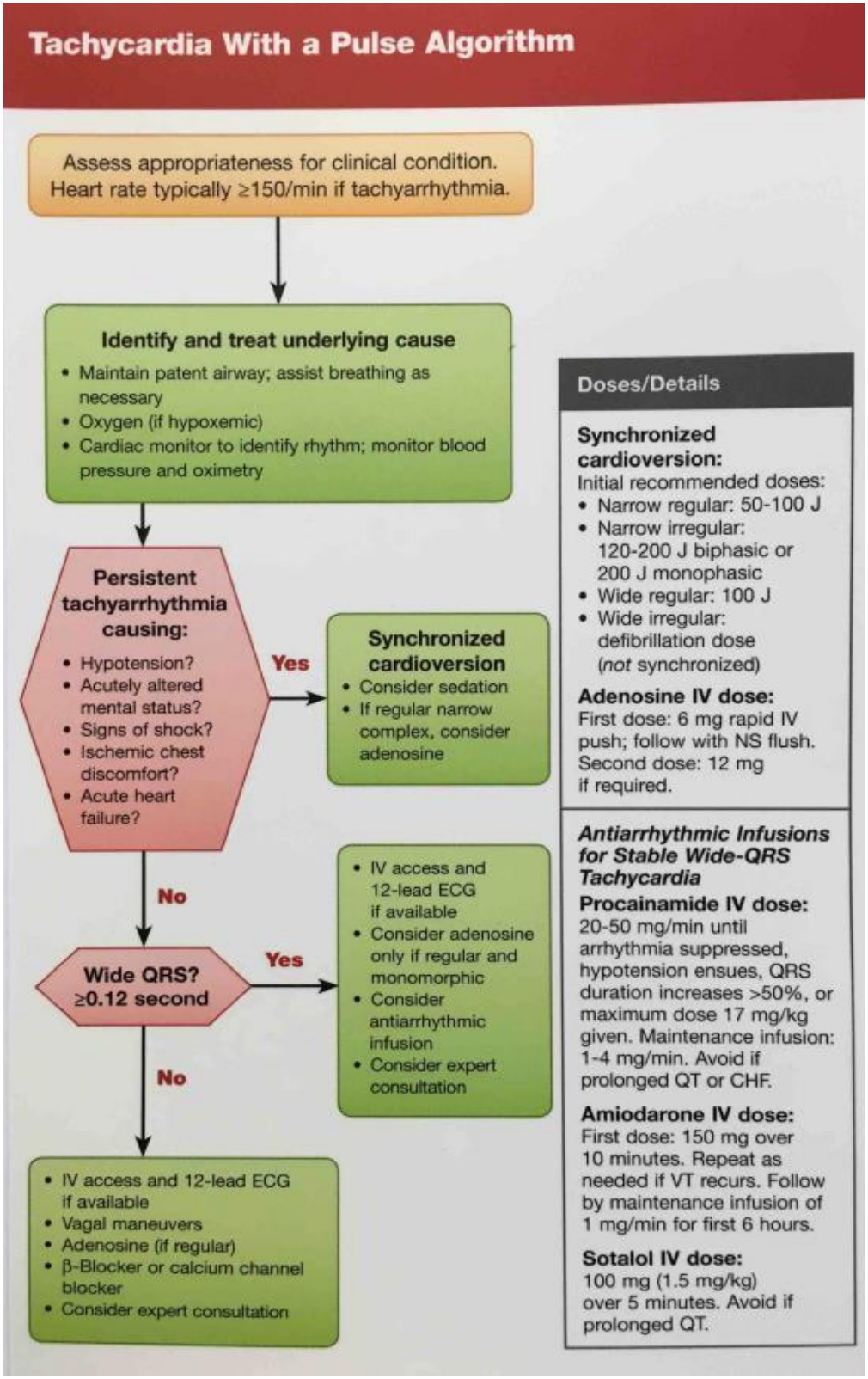
1) Early appropriate recognition and management of narrow complex tachycardia rhythms.
2) Recognition of poor perfusion attributed to a narrow complex tachycardia rhythm.

B) General Information:

- Signs and symptoms of a hemodynamically unstable patient include:
  a) Altered mental status
  b) Ongoing chest discomfort
  c) Shortness of breath
  d) Hypotension
  e) Shock
- Heart rate of 150/minute is one factor to distinguish SVT from sinus tach. Younger adult patients may experience sinus tach at rates greater than 150/minute and older patients may have SVT at rates lower than 150/minute. Other considerations should include presence/absence of P waves, beat to beat variability and patient history; if unsure of treatment contact medical control.
- If the patient has cocaine-induced SVT, administer Valium 5 mg IV/IO.

C) Warnings/Alerts

- Avoid low energy unsynchronized defibrillations. Low energy unsynchronized defibrillations are likely to induce ventricular fibrillation.
- If unable to obtain synchronization, deliver unsynchronized shock at defibrillation energy (manufacturer recommendations) not to delay cardioversion for administration of sedation to the unstable patient.
- It is the responsibility of the provider delivering the shock to ensure that no one is touching the patient prior to shock delivery.
- The following conditions need to be addressed prior to cardioversion:
  a) Patients in standing water
  b) Patients with transdermal medications
- Adenosine is contra-indicated in patients with a history of WPW.


Tachycardia With a Pulse Algorithm
Assess appropriateness for clinical condition. Heart rate typically ≥150/min if tachyarrhythmia.
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen (if hypoxemic)
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
Persistent tachyarrhythmia causing:
• Hypotension?
• Acutely altered mental status?
• Signs of shock?
• Ischemic chest discomfort?
• Acute heart failure?
Yes
Synchronized cardioversion
• Consider sedation
• If regular narrow complex, consider adenosine
No
Wide QRS? ≥0.12 second
Yes
• IV access and 12-lead ECG if available
• Consider adenosine only if regular and monomorphic
• Consider antiarrhythmic infusion
• Consider expert consultation
No
• IV access and 12-lead ECG if available
• Vagal maneuvers
• Adenosine (if regular)
• β-Blocker or calcium channel blocker
• Consider expert consultation
Doses/Details
Synchronized cardioversion:
Initial recommended doses:
• Narrow regular: 50-100 J
• Narrow irregular: 120-200 J biphasic or 200 J monophasic
• Wide regular: 100 J
• Wide irregular: defibrillation dose (not synchronized)
Adenosine IV dose:
First dose: 6 mg rapid IV push; follow with NS flush. Second dose: 12 mg if required.
Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia
Procainamide IV dose:
20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given. Maintenance infusion: 1-4 mg/min. Avoid if prolonged QT or CHF.
Amiodarone IV dose:
First dose: 150 mg over 10 minutes. Repeat as needed if VT recurs. Follow by maintenance infusion of 1 mg/min for first 6 hours.
Sotalol IV dose:
100 mg (1.5 mg/kg) over 5 minutes. Avoid if prolonged QT.

IV. ADULT CARDIAC CARE PROTOCOLS

4 Cont. ***Adult Tachycardia - Wide***

A) Objectives

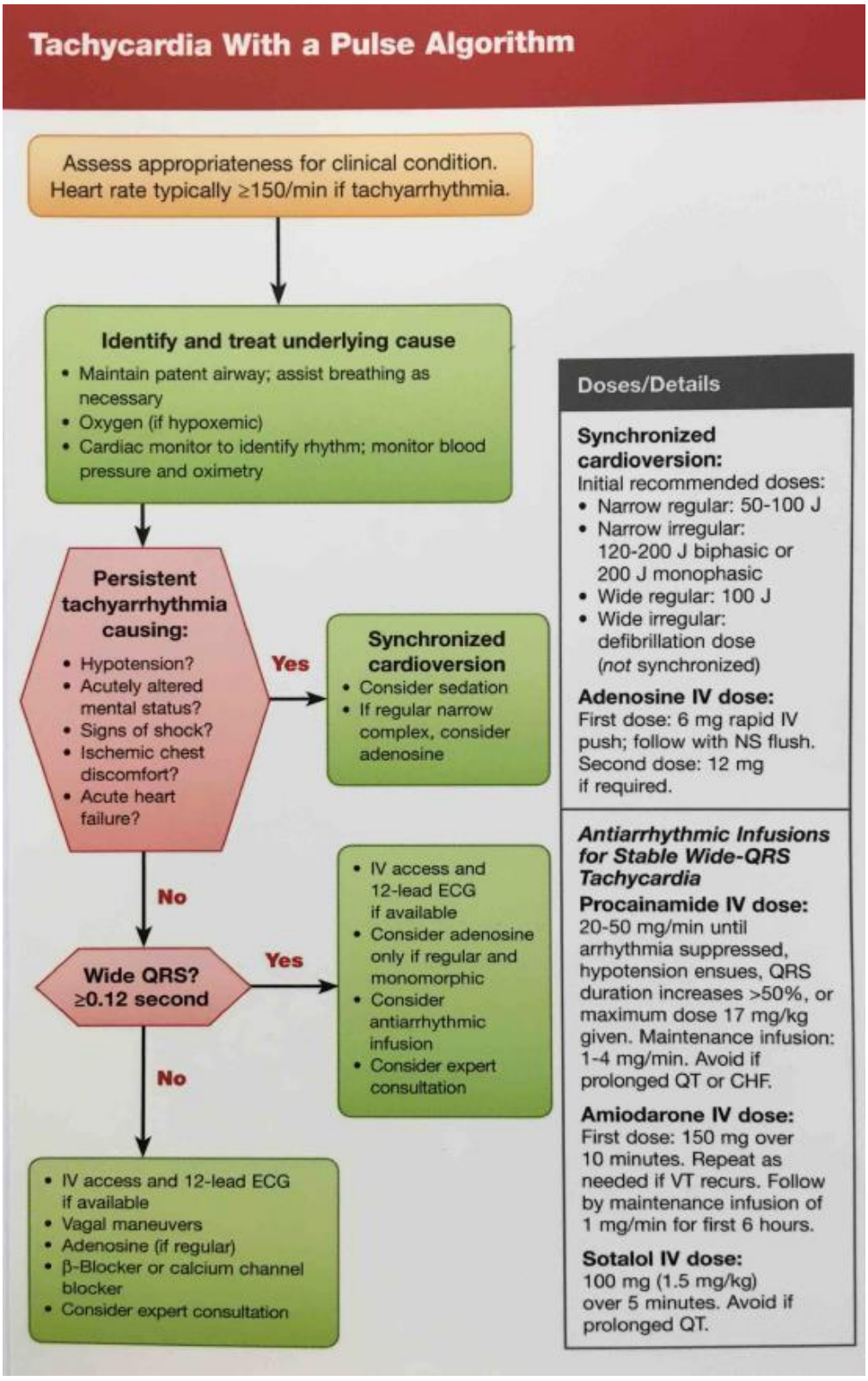
1) Early appropriate recognition and management of tachycardia rhythms.
2) Recognition of poor perfusion attributed to a tachycardia rhythm Adult Tachycardia – Wide Complex.

B) General Information

- Signs and Symptoms of a hemodynamically unstable patient include:
  a) Altered mental status
  b) Ongoing chest discomfort
  c) Shortness of breath
  d) Hypotension
  e) Shock
- Although not common, V-Tach can occur at rates less than 150; if unsure of treatment contact medical control

C) Warnings/Alerts

- Polymorphic VT can deteriorate quickly to VF – defibrillate ASAP.
- Avoid low energy unsynchronized defibrillations. Low energy unsynchronized defibrillations are likely to induce ventricular fibrillation.
- If unable to obtain synchronization, deliver unsynchronized shock at defibrillation energy (manufacturer recommendations).
- Do not delay cardioversion for administration of sedation to the unstable patient.
- It is the responsibility of the provider delivering the shock to ensure that no one. Is touching the patient prior to shock delivery
- The following conditions need to be addressed prior to cardioversion
  a) Patients in standing water
  b) Patients with transdermal medications
- Other conditions may mimic wide complex tachycardia
  a) Internal pacemakers
  b) Aberrancy


Tachycardia With a Pulse Algorithm
Assess appropriateness for clinical condition. Heart rate typically ≥150/min if tachyarrhythmia.
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen (if hypoxemic)
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
Persistent tachyarrhythmia causing:
• Hypotension?
• Acutely altered mental status?
• Signs of shock?
• Ischemic chest discomfort?
• Acute heart failure?
Yes
Synchronized cardioversion
• Consider sedation
• If regular narrow complex, consider adenosine
No
Wide QRS? ≥0.12 second
Yes
• IV access and 12-lead ECG if available
• Consider adenosine only if regular and monomorphic
• Consider antiarrhythmic infusion
• Consider expert consultation
No
• IV access and 12-lead ECG if available
• Vagal maneuvers
• Adenosine (if regular)
• β-Blocker or calcium channel blocker
• Consider expert consultation
Doses/Details
Synchronized cardioversion:
Initial recommended doses:
• Narrow regular: 50-100 J
• Narrow irregular: 120-200 J biphasic or 200 J monophasic
• Wide regular: 100 J
• Wide irregular: defibrillation dose (not synchronized)
Adenosine IV dose:
First dose: 6 mg rapid IV push; follow with NS flush. Second dose: 12 mg if required.
Antiarrhythmic Infusions for Stable Wide-QRS Tachycardia
Procainamide IV dose:
20-50 mg/min until arrhythmia suppressed, hypotension ensues, QRS duration increases >50%, or maximum dose 17 mg/kg given. Maintenance infusion: 1-4 mg/min. Avoid if prolonged QT or CHF.
Amiodarone IV dose:
First dose: 150 mg over 10 minutes. Repeat as needed if VT recurs. Follow by maintenance infusion of 1 mg/min for first 6 hours.
Sotalol IV dose:
100 mg (1.5 mg/kg) over 5 minutes. Avoid if prolonged QT.

IV. ADULT CARDIAC CARE PROTOCOLS

5. ***Return of Spontaneous Circulation (ROSC)***

A) Objectives

1) To appropriately treat patients who have return of spontaneous circulation.
2) To ensure adequate perfusion.

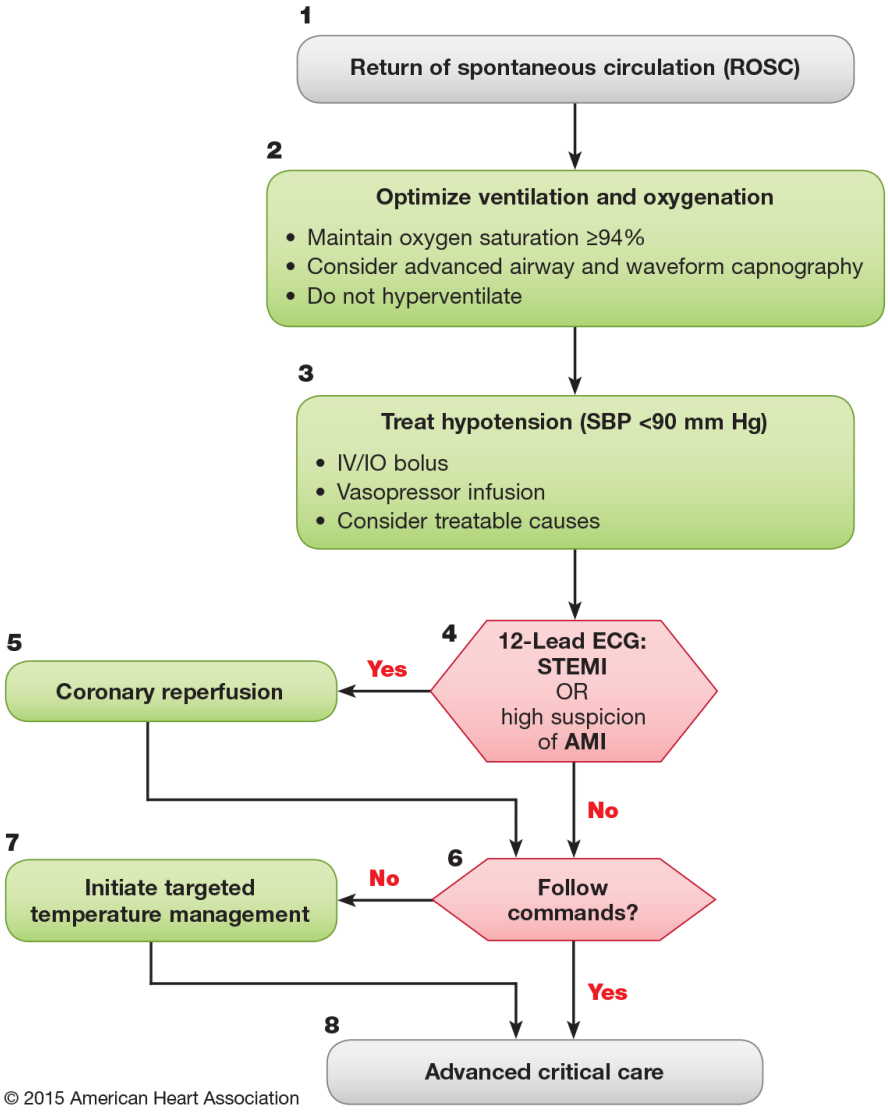
B) General Information

- Amiodarone:
  a) 150 mg in 100 ml over 10 minutes
  b) Do not use in the same IV line with furosemide, heparin or sodium bicarbonate
- Dopamine:
  a) Starting dose 2 mcg/kg/min
  b) Max dose of 20 mcg/kg/min
  c) Titrate to systolic blood pressure of 90-100 mm/Hg
  d) Mix 400 mg in 250 ml NS for a concentration of 1600 mcg/ml; see reference chart for drip rate

C) Warnings/ Alerts

- Amiodarone is contraindicated in the following conditions:
  a) Bradycardia
  b) Heart block
  c) Hypotension
  d) Pulmonary edema
  e) Cardiogenic shock

Adult Immediate Post–Cardiac Arrest Care Algorithm—2015 Update



Doses/Details

Ventilation/oxygenation: Avoid excessive ventilation. Start at 10 breaths/min and titrate to target P_{ETCO_2} of 35-40 mm Hg. When feasible, titrate F_{IO_2} to minimum necessary to achieve Spo_2 ≥94%.

IV bolus: Approximately 1-2 L normal saline or lactated Ringer's

Epinephrine IV infusion: 0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Dopamine IV infusion: 5-10 mcg/kg per minute

Norepinephrine IV infusion: 0.1-0.5 mcg/kg per minute (in 70-kg adult: 7-35 mcg per minute)

Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

6. ***Termination of resuscitation***

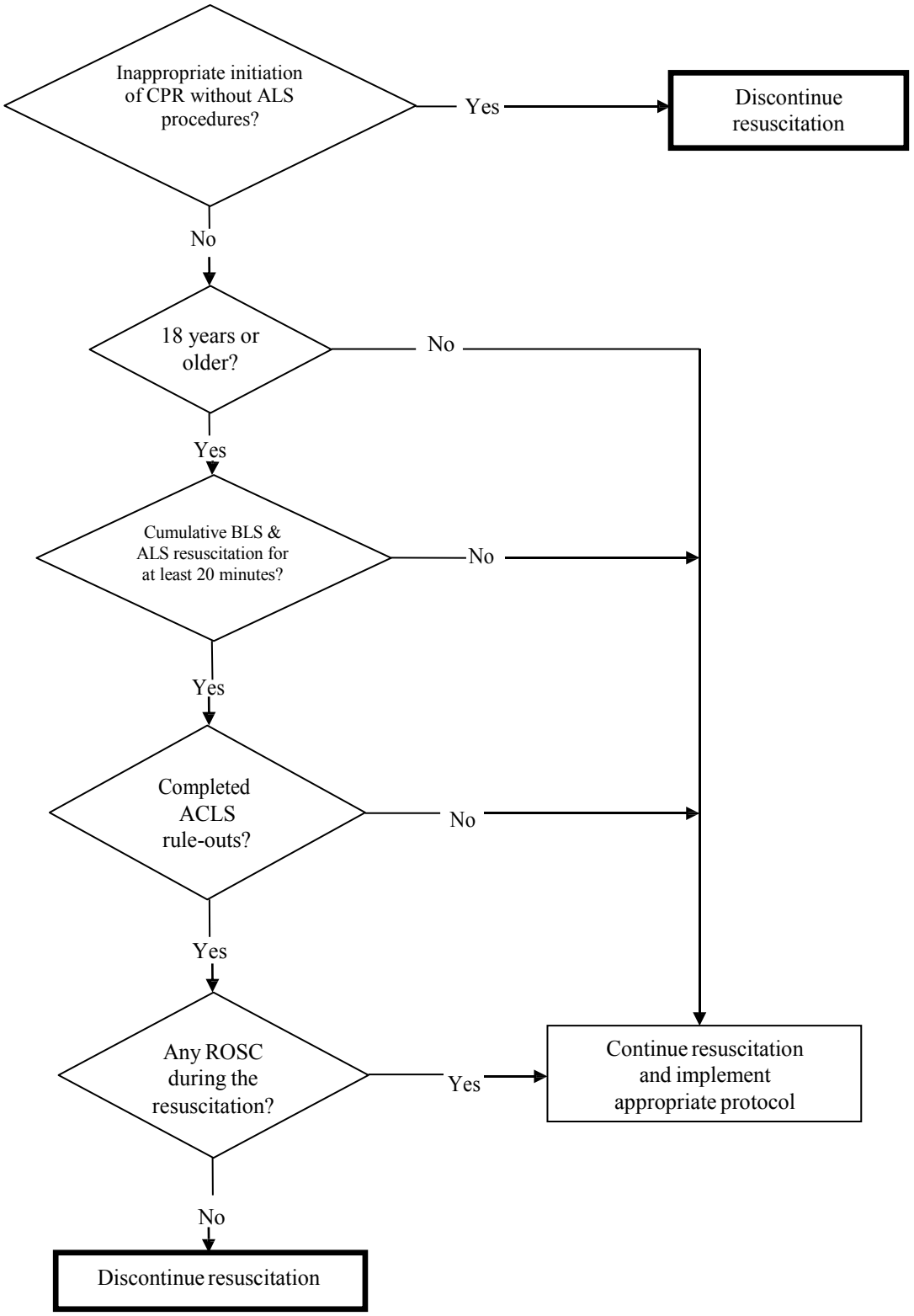
A) Objectives
   1) To provide criteria for field terminating resuscitation.

B) General Information
- Contraindications to using the protocol include patients who are exhibiting neurological activity, patients under 18 years old, or patients with suspected hypothermia.
- Inappropriate initiation of CPR includes patients with dependent lividity, rigor mortis, injuries incompatible with life or a valid DNR.
- Resuscitation must continue while you are evaluating the patient.
- Patients in cardiac arrest from environmental causes may warrant resuscitation efforts greater than 20 minutes (ie hypothermia, submersion injuries etc.).
- Once resuscitation has been discontinued
  a) Distribute bereavement booklet to family members, if available
  b) Leave all expendable ALS supplies in place

C) Warnings / Alerts

- This protocol is not to be used during transport (transport is defined as moving the patient into the aircraft)
- Recent studies have shown that resuscitation outcomes for witnessed arrest have had ROSC at times greater than 20 minutes while maintaining a refractory Ventricular Fibrillation rhythm in these patients. Sound judgment and all aspects of the patient situation should be held into consideration prior to any termination of efforts in these patients.

Termination of resuscitation



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V. PEDIATRIC GUIDELINES

1. General information:

Pediatric and Neonatal patients are not typically in the SAR Medical Technicians Scope of Practice, but have the potential to become patients under our care. The following charts are tools to help the SAR Medical Technician in treatment of Pediatric and Neonatal patients.

References to ALS EMS Field Guide (AHA2015), AHA ACLS/PALS Handbook, or BRASLOW Child Reference Tape shall be done anytime treatment is being conducted on a Pediatric or Neonatal patient. Next level of care shall be notified while transporting Pediatric and Neonatal patients.

2. Important reminders for providers treating Pediatric and Neonatal patients:

- Up until the age of 8, a child's head is proportionally large and contains 25% of total body weight.
- A Child's Airway is narrower and less stable at all levels than those of adults.
- Small amounts of blood loss in children can cause shock.
- Children can compensate in shock for long periods of time, during this time it is vital to perform lifesaving and shock treatment. When children start to decompensate in shock it tends to be irreversible. Aggressive stabilization of Pediatric and Neonate patients is key to managing these patients.

3. Clinical Reference charts for Pediatric(s) / Neonate(s):

Age	Preterm	Term	6 Months	1YR	3YR	6YR	8YR	10YR	11YR	12YR	14YR
Weight lbs.	3	7.5	15	22	33	44	55	66	77	88	99
Weight kg	1.5	3.5	7	10	15	20	15	30	35	40	45
Length in.	16	21	26	31	39	46	50	54	57	60	64
Length cm	41	53	66	79	99	117	127	137	145	152	163
Heart Rate	140	125	120	120	110	100	90	90	85	85	80
Respirations	40-60	40-60	24-36	22-30	20-26	20-24	18-22	18-22	16-22	16-22	14-22
Systolic B/P	50-60	60-70	60-120	65-125	100	100	105	110	110	115	115
ET Tube (mm)	2.5,3.0	3.5	3.5	4	4.5	5.5	6	6.5	6.5	7	7
Suction Cath	5-6 Fr	8 Fr	8 Fr	8 Fr	8 Fr	10 fr	10 Fr	10 fr	10 Fr	10 Fr	10 Fr
Defibrillation:											
2 J/kg (Initial)	3J	7J	14J	20J	30J	40J	50J	60J	70J	80J	90J
4 J/kg (Repeat)	6J	14J	28J	40J	60J	80J	100J	120J	140J	160J	180J
8 J/kg (Repeat)	12J	28J	56J	80J	120J	160J	200J	240J	280J	320J	360J
10 J/kg (Repeat)	15J	35J	70J	100J	150J	200J	250J	300J	350J	360J	360J
Cardioversion:											
0.5-2J/kg	1-3J	2-7J	4-14J	5-20J	8-30J	10-40J	13-50J	15-60J	18-70J	20-80J	23-90J
Fluid Challenge:											
20ml/kg IV/IO	15ml	35ml	140ml	200ml	300ml	400ml	500ml	600ml	700ml	800ml	900ml
Neonates: 10ml/kg	10ml/kg	10ml/kg									

V. PEDIATRIC GUIDELINES

2. Clinical Reference charts for Pediatric(s) / Neonate(s):

Age	Preterm	Term	6 Months	1YR	3YR	6YR	8YR	10YR	11YR	12YR	14YR
Weight kg	1.5	3.5	7	10	15	20	15	30	35	40	45
Amiodarone (50mg/ml) 5mg/kg IV/IO	0.15ml	0.35ml	0.7ml	1ml	1.5ml	2ml	2.5ml	3ml	3.5ml	4ml	4.5ml
Atropine (0.1mg/ml) 0.02 mh/kg IV/IO	1ml	1ml	1.4ml	2ml	3ml	4ml	5ml	6ml	7ml	8ml	9ml
Dextrose (D50%w) 0.5gm/kg IV/IO {use D25%W for infant}	3ml D25%	7ml D25%	14ml D25%	20ml D25%	15ml	20ml	25ml	30ml	35ml	40ml	45ml
Diazepam (5mg/ml) 0.1-0.3 mg/kg IV/IO	0.03-0.09ml	0.07-0.21ml	0.14-0.42ml	0.2-0.6ml	0.3-0.9ml	0.4-1.2ml	0.5-1.5ml	0.6-1.8ml	0.7-2.1ml	0.8-2.4ml	0.9-2.7ml
EPI 1:10,000 (o.1mg/ml) 0.01 mg/kg IV/IO	0.15ml	0.35ml	0.7ml	1ml	1.5ml	2ml	2.5ml	3ml	3.5ml	4ml	4.5ml
ET EPI 1:1,000 (1mg/ml) 0.1 mg/kg ET	0.15ml	0.35ml	0.7ml	1ml	1.5ml	2ml	2.5ml	3ml	3.5ml	4ml	4.5ml
Etomidate (2mg/ml) 0.3mg/kg IV/IO	0.2ml	0.5ml	1ml	1.5ml	2.3ml	3ml	3.8ml	4.5ml	5.3ml	6ml	6.8ml
Morphine (1mg/ml) 0.1mg/kg IV/IO/IM	0.15ml	0.35ml	0.7ml	1ml	1.5ml	2ml	2.5ml	3ml	3.5ml	4ml	4.5ml
Naloxone (0.4 mg/ml) 0.1 mg/kg IV/IO/IM/SQ	0.4ml	0.9ml	1.8ml	2.5ml	3.8ml	5ml	5ml	5ml	5ml	5ml	5ml
Succinylcholine (20mg/ml) 1mg/kg IV/IO {infant: 2mg/kg}	0.15ml 2mk/kg	0.35ml 2mg/kg	0.7ml 2mg/kg	1ml 2mg/kg	0.75ml	1ml	1.25ml	1.5ml	1.75ml	2ml	2.3ml

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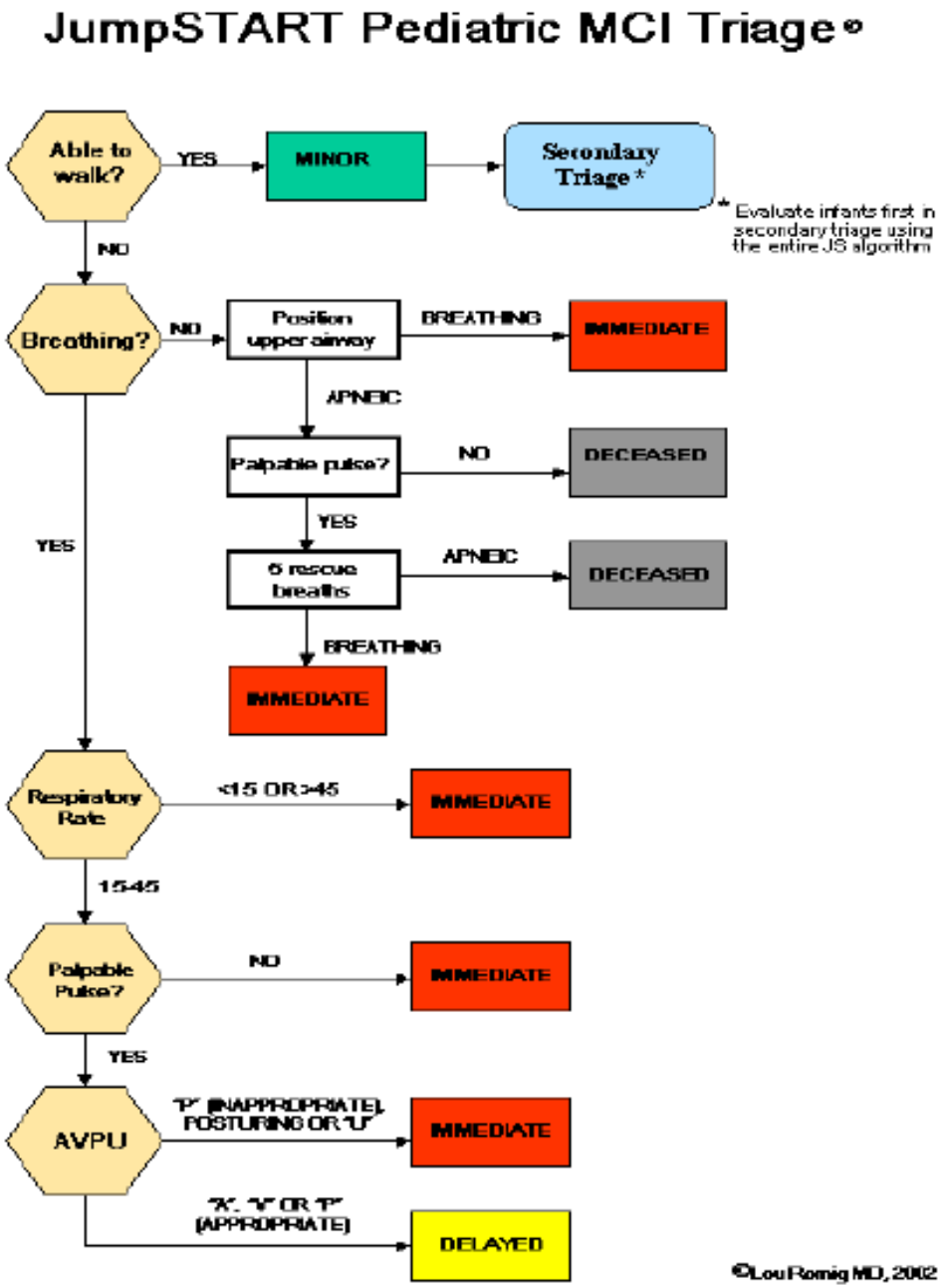
3. Jump START Triage



JumpStart Triage

Indications: Trauma patients who meet any of the following criteria shall be transported to the **closest appropriate** trauma center within a 30-minute ground transport time. Trauma patients who are not within 30 minutes ground transport time of a trauma center should be transported to the closest hospital if they cannot be delivered to an appropriate facility more rapidly by air ambulance.

Physiologic Criteria

- Glascow Coma Scale less than 14, or
- Systolic blood pressure of less than 90 mm/Hg, or
- Respiratory rate of less than 10 or greater than 29 breaths per minute (less than 20 breaths per minute in infants less than 1 year old)

Anatomic Criteria

- Penetrating injuries to head, neck, torso and extremities proximal to elbow or knee
- Flail Chest
- 2 or more proximal long bone fracures
- Crushed, degloved or mangled extremity
- Amputation proximal to wrist or ankle
- Pelvic fractures
- Open or depressed skull fractures
- Paralysis

Mechanism of Injury

- **Falls**
  - Adults – greater than 20 feet
  - Children less than 15 years old – greater than 10 feet, or 2-3 times the child's height
- **High-risk auto crash**
  - Intrusion- more than 12 inches to the occupant site or more than 18 inches to any site
  - Ejection (partial or complete) from automobile
  - Death in the same passenger compartment
  - Vehicle telemetry data consistent with high risk of injury
- **Auto versus pedestrian / bicyclists**- thrown, run over or with significant (greater than 20 mph) impact
- **Motorcycle crash** at speed greater than 20 mph
- **Special Considerations**
- **Burns** (with or without other trauma) – absent other trauma, burns that meet Burn Center criteria should be transported to a burn center
- **Pregnancy**- Injured women who are more than 20 weeks pregnant should be considered for transport to a trauma center or a hospital with obstetrical resources
- **Age** – greater than 55 years of age
- **Anticoagulation and Bleeding Disorders** – EMS should contact medical control and consider transport to trauma center
- **Time- Sensitive Extremity Injury** – open fracture(s) or fracture(s) with neurovascular compromise
- **EMS Provider Judgment** – EMS provides, based on experience and expertise, may always exercise clinical judgment regarding atypical patient presentations

V. PEDIATRIC GUIDELINES

4. APGAR / Glasgow Coma Scale

APGAR / Glasgow Coma Scale Score / Pain Rating Scale

APGAR

Sign	0	1	2
Appearance (skin color)	Blue, pale	Body pink, blue extremities	Completely pink
Pulse rate (heart rate)	Absent	<100 beats/minute	>100 beats/minute
Grimace (irritability)	No response	Grimace	Cough, sneeze, cry
Activity (muscle tone)	Limp	Some flexion	Active motion
Respirations (effort)	Absent	Slow, irregular	Good, crying

Pediatric Glasgow Coma Scale (GCS) Score

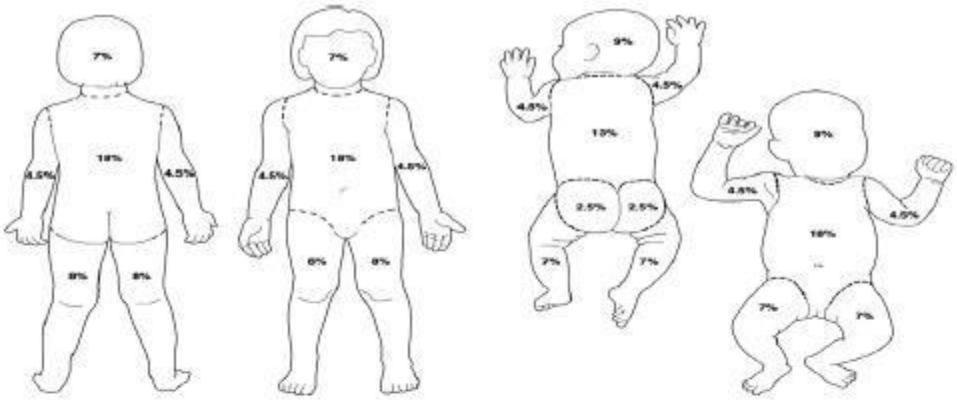
Eye	Verbal	Motor
4 – Spontaneous eye opening 3 – Eye opening on command 2 – Eye opening to painful stimulus 1 – No eye opening *If eye(s) cannot be opened due to severe swelling, the patient should receive the score based on what he/she would be able to do	*>5 Years of Age* 5 – Oriented and converses 4 – Disoriented and converses 3 – Inappropriate words 2 – Incomprehensible sounds 1 – Makes no verbal response *2-5 Years of Age* 5 – Appropriate words and phrases 4 – Inappropriate words 3 – Cries/screams 2 – Grunts 1 – Makes no verbal response *Birth to 2 Years of Age* 5 – Cries appropriately, smiles, coos 4 – Cries 3 – Inappropriate crying/screaming 2 – Grunts 1 – Makes no verbal response *See note about intubation	6 – Follows command 5 – Localizes painful stimuli 4 – Withdrawal to pain 3 – Responds with abnormal flexion to painful stimuli (decorticate) 2 – Responds with abnormal extension to painful stimuli (decerebrate) 1 – Gives no motor response
• If patient intubated, GCS score contains only eye and motor scales and a "T" is added to note the inability to assess verbal response (e.g., "8T")		

Pediatric Pain Rating Scale

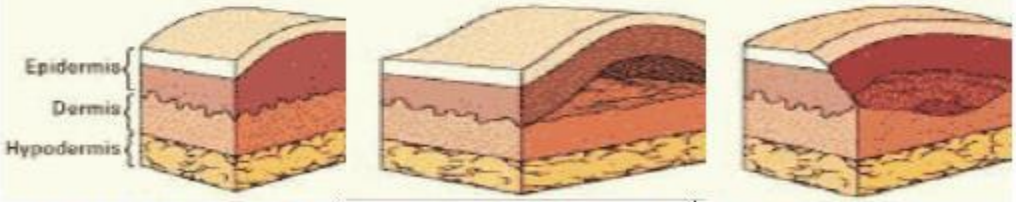
Explain to the child that each face is for a person who feels happy because there is no pain (hurt) or sad because there is some or a lot of pain. Face 0 is very happy because there is no hurt. Face 2 hurts just a little bit. Face 4 hurts a little more. Face 6 hurts even more. Face 8 hurts a whole lot, but Face 10 hurts as much as you can imagine, although you do not have to be crying to feel this bad. Ask child to choose the face that best describes the child's own pain. Record the number under chosen face on patient care report.

V. PEDIATRIC GUIDELINES

5. Neonate / Pediatric Burn Reference



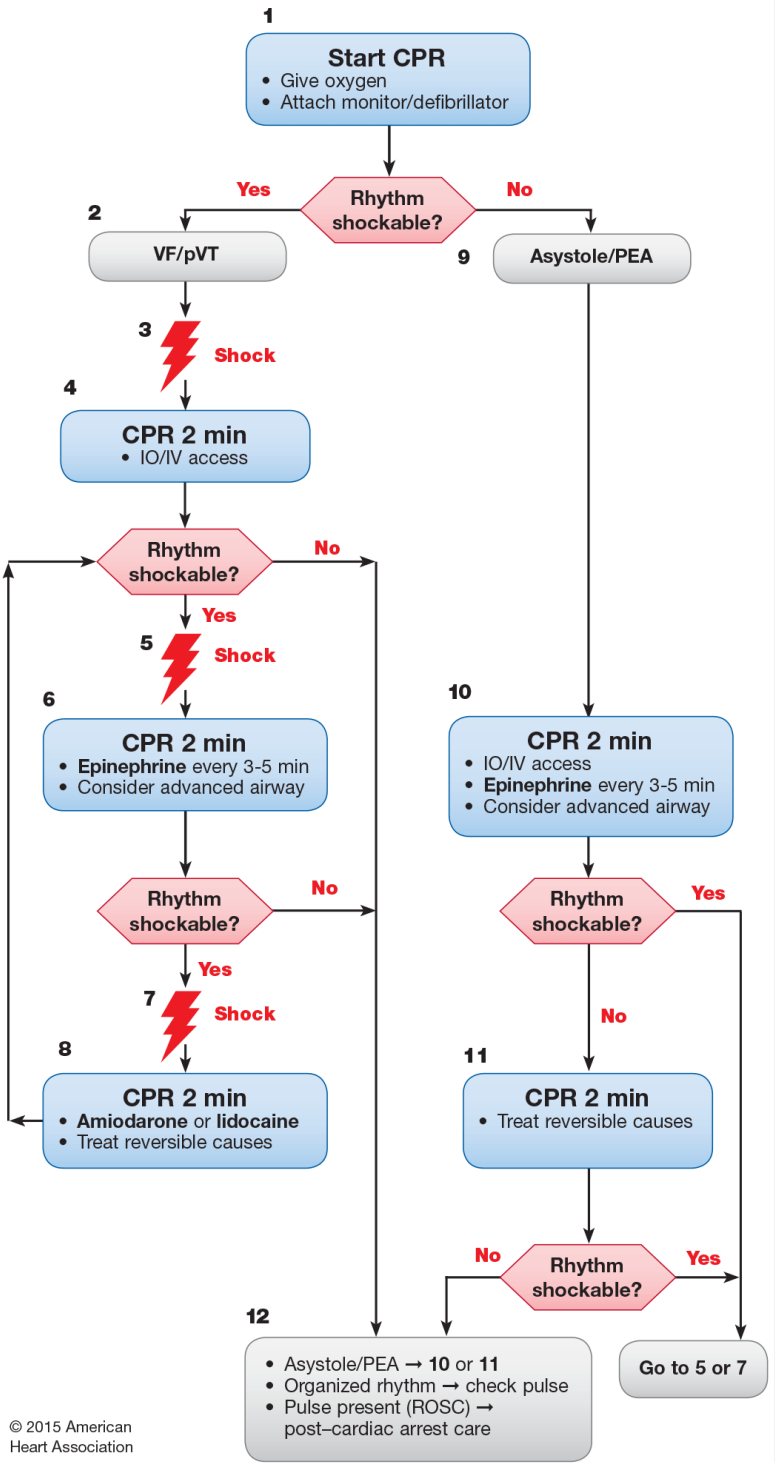
Palm Method:
The palm method is a tool whereby the size of the patients palm is used as an indicator for specific percentage of TBSA.
The surface area of a patients palm equals approximately 1% of TBSA.
This method is particularly useful where the burn has an irregular shape or has a scattered distribution.

Superficial (First-Degree)	Partial Thickness (Second-Degree)	Full Thickness (Third-Degree)
		
Damage to the outer layer of skin {epidermis}, causing pain, redness and swelling.	Damage to both outer skin and underlying tissue layers {epidermis and dermis} causing pain, redness, swelling and blistering.	Damage extends deeper into tissues {epidermis, dermis and hypodermis} causing extensive tissue destruction. The skin may feel numb.

V. PEDIATRIC GUIDELINES

6. Pediatric Cardiac Arrest

Pediatric Cardiac Arrest Algorithm—2015 Update



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CPR Quality

- Push hard (≥⅓ of anteroposterior diameter of chest) and fast (100-120/min) and allow complete chest recoil.
- Minimize interruptions in compressions.
- Avoid excessive ventilation.
- Rotate compressor every 2 minutes, or sooner if fatigued.
- If no advanced airway, 15:2 compression-ventilation ratio.

Shock Energy for Defibrillation

First shock 2 J/kg, second shock 4 J/kg, subsequent shocks ≥4 J/kg, maximum 10 J/kg or adult dose

Drug Therapy

- **Epinephrine IO/IV dose:** 0.01 mg/kg (0.1 mL/kg of 1:10 000 concentration). Repeat every 3-5 minutes.
  If no IO/IV access, may give endotracheal dose: 0.1 mg/kg (0.1 mL/kg of 1:1000 concentration).
- **Amiodarone IO/IV dose:** 5 mg/kg bolus during cardiac arrest. May repeat up to 2 times for refractory VF/pulseless VT.
- **Lidocaine IO/IV dose:** Initial: 1 mg/kg loading dose. Maintenance: 20-50 mcg/kg per minute infusion (repeat bolus dose if infusion initiated >15 minutes after initial bolus therapy).

Advanced Airway

- Endotracheal intubation or supraglottic advanced airway
- Waveform capnography or capnometry to confirm and monitor ET tube placement
- Once advanced airway in place, give 1 breath every 6 seconds (10 breaths/min) with continuous chest compressions

Return of Spontaneous Circulation (ROSC)

- Pulse and blood pressure
- Spontaneous arterial pressure waves with intra-arterial monitoring

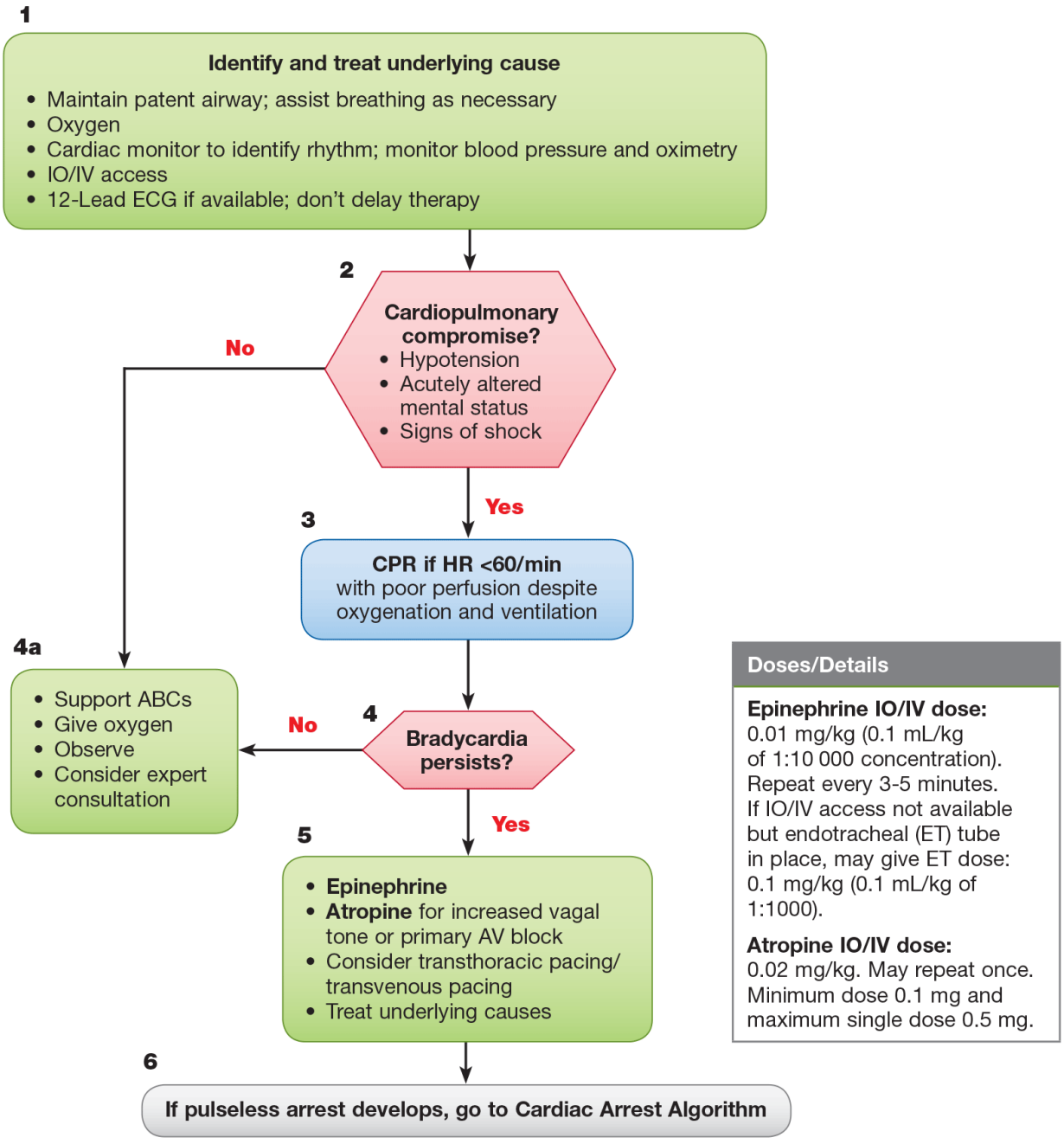
Reversible Causes

- **H**ypovolemia
- **H**ypoxia
- **H**ydrogen ion (acidosis)
- **H**ypoglycemia
- **H**ypo-/hyperkalemia
- **H**ypothermia
- **T**ension pneumothorax
- **T**amponade, cardiac
- **T**oxins
- **T**hrombosis, pulmonary
- **T**hrombosis, coronary

V. PEDIATRIC GUIDELINES

7. Pediatric Bradycardia

Pediatric Bradycardia With a Pulse and Poor Perfusion Algorithm


1
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
• IO/IV access
• 12-Lead ECG if available; don't delay therapy
2
Cardiopulmonary compromise?
• Hypotension
• Acutely altered mental status
• Signs of shock
No
Yes
3
CPR if HR <60/min with poor perfusion despite oxygenation and ventilation
4
Bradycardia persists?
No
Yes
4a
• Support ABCs
• Give oxygen
• Observe
• Consider expert consultation
5
• Epinephrine
• Atropine for increased vagal tone or primary AV block
• Consider transthoracic pacing/ transvenous pacing
• Treat underlying causes
6
If pulseless arrest develops, go to Cardiac Arrest Algorithm
Doses/Details
Epinephrine IO/IV dose:
0.01 mg/kg (0.1 mL/kg of 1:10 000 concentration). Repeat every 3-5 minutes. If IO/IV access not available but endotracheal (ET) tube in place, may give ET dose: 0.1 mg/kg (0.1 mL/kg of 1:1000).
Atropine IO/IV dose:
0.02 mg/kg. May repeat once. Minimum dose 0.1 mg and maximum single dose 0.5 mg.

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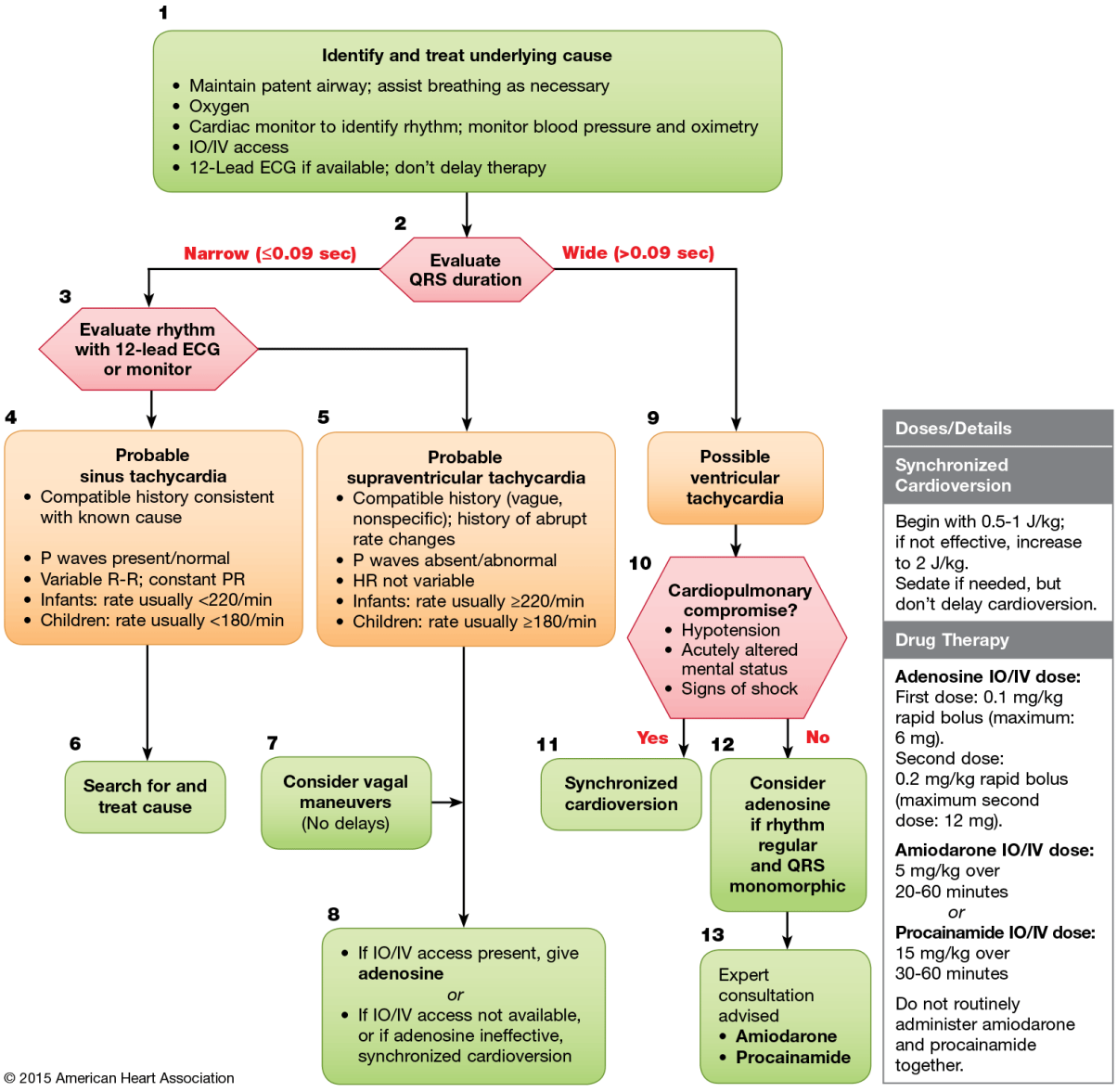
V. PEDIATRIC GUIDELINES

8. Pediatric Tachycardia

Pediatric Tachycardia With a Pulse and Poor Perfusion Algorithm


1
Identify and treat underlying cause
• Maintain patent airway; assist breathing as necessary
• Oxygen
• Cardiac monitor to identify rhythm; monitor blood pressure and oximetry
• IO/IV access
• 12-Lead ECG if available; don't delay therapy
2
Evaluate QRS duration
Narrow (≤0.09 sec)
Wide (>0.09 sec)
3
Evaluate rhythm with 12-lead ECG or monitor
4
Probable sinus tachycardia
• Compatible history consistent with known cause
• P waves present/normal
• Variable R-R; constant PR
• Infants: rate usually <220/min
• Children: rate usually <180/min
5
Probable supraventricular tachycardia
• Compatible history (vague, nonspecific); history of abrupt rate changes
• P waves absent/abnormal
• HR not variable
• Infants: rate usually ≥220/min
• Children: rate usually ≥180/min
9
Possible ventricular tachycardia
10
Cardiopulmonary compromise?
• Hypotension
• Acutely altered mental status
• Signs of shock
Yes
No
6
Search for and treat cause
7
Consider vagal maneuvers (No delays)
8
• If IO/IV access present, give adenosine
or
• If IO/IV access not available, or if adenosine ineffective, synchronized cardioversion
11
Synchronized cardioversion
12
Consider adenosine if rhythm regular and QRS monomorphic
13
Expert consultation advised
• Amiodarone
• Procainamide
Doses/Details
Synchronized Cardioversion
Begin with 0.5-1 J/kg; if not effective, increase to 2 J/kg.
Sedate if needed, but don't delay cardioversion.
Drug Therapy
Adenosine IO/IV dose:
First dose: 0.1 mg/kg rapid bolus (maximum: 6 mg).
Second dose: 0.2 mg/kg rapid bolus (maximum second dose: 12 mg).
Amiodarone IO/IV dose:
5 mg/kg over 20-60 minutes
or
Procainamide IO/IV dose:
15 mg/kg over 30-60 minutes
Do not routinely administer amiodarone and procainamide together.
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VI. ***TACTICAL COMBAT CASUALTY CARE (TCCC)***

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VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

1. Abbreviated TCCC Guidelines

Basic Management Plan for Care Under Fire

Return Fire and take cover

Direct or expect casualty to remain engaged as a combatant if appropriate

Direct casualty to move to cover and apply self-aid if able.

Try to keep the casualty from sustaining additional wounds.

Stop life-threatening external hemorrhage if tactically feasible:
- Direct casualty to control hemorrhage by self-aid if able.

Use a CoTCCC-recommended limb tourniquet for extremity hemorrhage
- Move the casualty to cover

Airway management is generally best deferred until the Tactical Field Care phase.

Basic Management Plan for Tactical Field Care

Establish Security Perimeter IAW Tactical SOPs. Maintain situational awareness.

Triage Casualties as required. Altered mental status is criteria to have weapons cleared/secured, communications gear secured and sensitive items redistributed.

Massive Hemorrhage

Assess for unrecognized hemorrhage and control all life-threatening bleeding.

Use one or more CoTCCC-recommended limb tourniquets if necessary.

Use a CoTCCC approved hemostatic dressing for compressible hemorrhage not amenable to limb tourniquet use.

Immediately apply a CoTCCC-recommended junctional tourniquet if the bleeding site is amenable to use of a junctional tourniquet.

Airway Management

Unconscious casualty without airway obstruction:
- -Chin lift or jaw thrust maneuver
- -Nasopharyngeal airway
- -Place the casualty in the recovery position

Casualty with airway obstruction or impending airway obstruction:
- -Allow a conscious casualty to assume any position that best protects the airway, to include sitting up
- -Chin lift or jaw thrust maneuver
- -Nasopharyngeal airway
- -Place an unconscious casualty in the recovery position

If the previous measures are unsuccessful perform a surgical cricothyroidotomy using one of the following:
- -CricKey technique
- -Bougie-aided open surgical technique
- -Standard open surgical technique

*Use lidocaine if the casualty is conscious

Basic Management Plan for Tactical Field Care continued

Respiration/Breathing

In a casualty with progressive respiratory distress and known or suspected torso trauma, consider a tension pneumothorax:

-Decompress the chest on the side of the injury at the primary or alternate site.

All open and/or sucking chest wounds should be treated by:

-Applying a vented chest seal (preferred)

-Applying a non-vented chest seal

-Burp the wound if indicated for breathing difficulty

Initiate pulsoximetry monitoring.

Monitor for tension pneumothorax.

Casualties with moderate/severe TBI should be given supplemental oxygen when available to maintain an oxygen saturation > 90%.

Circulation - Bleeding

Apply a pelvic binder for suspected pelvic fracture and/or severe blunt force or blast injury.

Reassess prior tourniquet application:

-Expose the wound and determine if a tourniquet is needed; if bleeding is not controlled then tighten tourniquet if possible.

-If the first tourniquet does not control bleeding after tightening, then add a second tourniquet side-by-side with the first.

Convert Limb tourniquets and junctional tourniquets if the following three criteria are met:

-The casualty is not in shock.

-It is possible to monitor the wound closely for bleeding.

-The tourniquet is not being used to control bleeding from an amputation.

Convert tourniquets in less than 2 hours if bleeding can be controlled with other means.

Expose and use an indelible marker to clearly mark all tourniquet sites with the time of tourniquet application, reapplication, conversion, or removal.

Circulation - IV/IO Access

Start an 18-gauge IV or Saline Lock if indicated.

If IV access is not obtainable, use an intraosseous (IO) needle.

Circulation - TXA

If a casualty is anticipated to need a blood transfusion, then administer 1 gram of tranexamic acid (TXA) in 100ml of NS or LR over 10min ASAP but NOT beyond 3 hours post injury.

Circulation - Fluid Resuscitation

Assess for hemorrhagic shock:

-If not in shock PO fluids are permissible if casualty is conscious and can swallow.

-If in shock resuscitate with:

Whole blood (preferred) or
Plasma, RBCs and platelets (1:1:1) or
Plasma and RBCs (1:1) or
Plasma or if blood products not available,
Hextend or Lactated Ringers or Plasma-Lyte-A

Resuscitate with above fluids until a palpable radial pulse, improved mental status or systolic BP of 80-90 mmHg is present. Discontinue fluids when one or more end points are achieved.

Reassess casualty frequently to check for recurrence of shock. If shock recurs, verify all hemorrhage is under control and repeat fluid resuscitation as above.

Basic Management Plan for Tactical Field Care continued

Hypothermia Prevention

Minimize casualty environmental exposure and promote heat retention.
Keep personal protective gear on if feasible. Replace wet clothing if possible. Get casualty onto insulated surface ASAP.
Use a hypothermia prevention kit with active rewarming.
If none above is available, then use dry blankets, poncho liners, or sleeping bags and keep the casualty warm and dry.
Warm IV fluids are preferred.

Penetrating Eye Trauma - If penetrating eye injury is noted or suspected:

Perform a rapid field test of visual acuity and document findings.
Cover eye with a rigid eye shield (not a pressure patch).
Administer Combat Wound Medication Pack if possible and/or administer IV/IM antibiotics per below.

Monitoring – Initiate advanced electronic monitoring of vital signs if available.

Analgesia/Pain Management

Analgesia on the battlefield should generally be achieved by one of three options:
Mild to Moderate Pain and/or Casualty can swallow and is still able to fight:
-Administer TCCC Combat Wound Medication Pack (CWMP)
Moderate to Severe Pain and casualty IS NOT in Shock
-Oral Transmucosal Fentanyl Citrate (OTFC) 800mcg
Moderate to Severe Pain and casualty is in hemorrhagic shock or respiratory distress
-Administer Ketamine 50mg IM or IN repeating q30min prn
OR
-Administer Ketamine 20mg Slow IV or IO repeating q20min prn

*Endpoint control of pain or development of nystagmus.
*Consider Ondansetron 4mg ODT/IV/IO/IM q8hours prn for nausea and vomiting.

Antibiotics

If able to take PO, then administer Moxifloxacin 400mg PO qDaily from CWPP.
If unable to take PO, administer Ertapenem 1 gram IV/IM qDaily.

Wounds

Inspect and dress known wounds.
Check for Additional Wounds.

Burns

Facial burns should be aggressively monitored for airway status and potential inhalation injury.
Estimate total body surface area (TBSA) burned to nearest 10%.
Cover burned areas with dry, sterile dressings. For burns >20% TBSA, consider placing casualty immediately in HPMK or other hypothermia prevention means.
Fluid Resuscitation (USAISR Rule of Ten):
-If burns >20% TBSA, initiate IV/IO fluids ASAP with Lactated Ringers, NS, or Hextend. If Hextend, then no more than 1000ml followed by LR or NS as needed.
-Initial IV/IO fluid rate = %TBSA X 10ml/per hour for adults 40-80 kg (+100ml/hr for every 10kg above 80kg).
-If hemorrhagic shock is present then resuscitate IAW fluid resuscitation in Circulation section.
All TCCC interventions may be performed on or through burned skin.

Basic Management Plan for Tactical Field Care continued

Splinting - Splint Fractures and Recheck Pulses.

Communication

- Communicate with the casualty if possible. Encourage, reassure, and explain care.
- Communicate with tactical leadership ASAP and throughout treatment. Provide casualty status and evac requirements.
- Communicate with the evacuation system to arrange TACEVAC.
- Communicate with medical personnel on evacuation assets and relay mechanism of injury, injuries sustained, signs/symptoms and treatments rendered.

Documentation

Document clinical assessments, treatments rendered, and changes in the casualty's status on a TCCC Casualty Card (DD Form 1380) and forward this information with the casualty to the next level of care.

Cardiopulmonary resuscitation (CPR)

- Battlefield blast or penetrating trauma casualties with no pulse, no ventilations, and no other signs of life should not be resuscitated.
- Casualties with torso trauma or polytrauma with no pulse or respirations should have bilateral needle decompression performed to confirm/deny tension pneumothorax prior to discontinuing care.

Prepare for Evacuation

- Complete and secure TCCC Card (DD1380) to casualty.
- Secure all loose ends of bandages and wraps.
- Secure hypothermia prevention wraps/blankets/straps.
- Secure litter straps and consider additional padding for long evacuations.
- Provide instructions to ambulatory patients as needed.
- Stage Casualties for evacuation.
- Maintain security at evacuation site.

Basic Management Plan for Tactical Evacuation Care (TACEVAC)

In addition to the principles of Tactical Field Care consider the following for Tactical Evacuation Care:

Transition of Care

Tactical force should establish evacuation point security and stage casualties for evacuation.
Tactical force personnel/medic should communicate patient status to TACEVAC personnel to include stable/unstable, injuries identified, and treatments rendered.
TACEVAC personnel stage casualties on evac platform as required.
Secure casualties on evac platform IAW unit policies, platform configurations, and safety requirements.
TACEVAC medical personnel reassess casualties and re-evaluate all injuries and interventions.

Airway Management- Consider the following for casualty with airway obstruction or impending airway obstruction:

-Supraglottic airway, or
-Endotracheal intubation

Breathing

Consider chest tube insertion if no improvement and/or long transport is anticipated.
Administer oxygen when possible for the following types of casualties:

-Low oxygen saturation by pulse oximetry
-Injuries associated with impaired oxygenation
-Unconscious casualty
-Casualty with TBI (maintain oxygen saturation > 90%)
-Casualty in shock
-Casualty at altitude

Traumatic Brain Injury-Casualties with moderate/severe TBI should be monitored for:

-Decreases in level of consciousness
-Pupillary dilation
-SBP should be >90 mmHg
-O2 sat > 90
-Hypothermia
-PCO2 (If capnography is available, maintain between 35-40 mmHg)
-Penetrating head trauma (if present, administer antibiotics)
-Assume a spinal (neck) injury until cleared

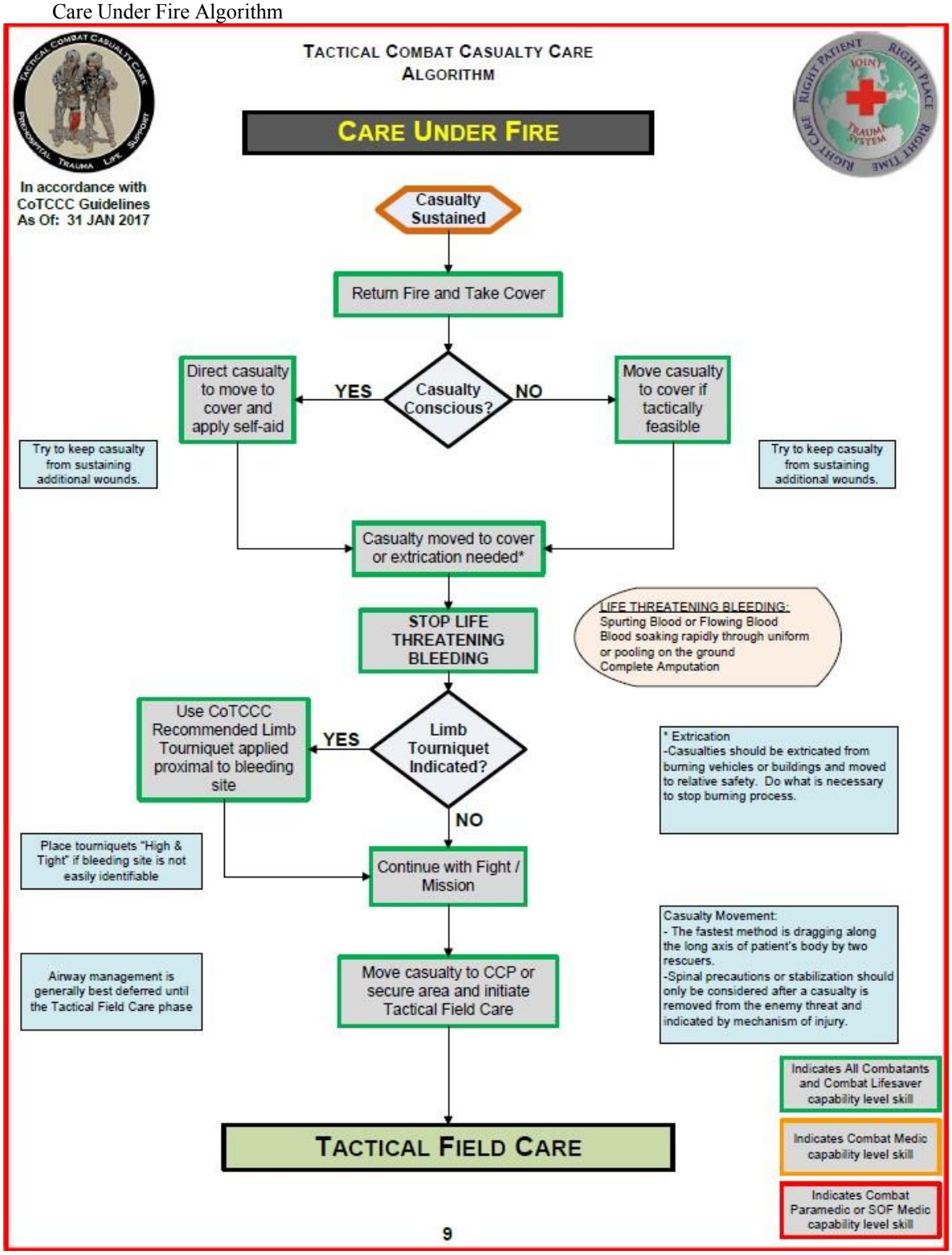
If impending herniation is suspected take the following actions:

-Administer 250 cc of 3 or 5% hypertonic saline bolus
-Elevate the casualty's head 30 degrees
-Hyperventilate the casualty

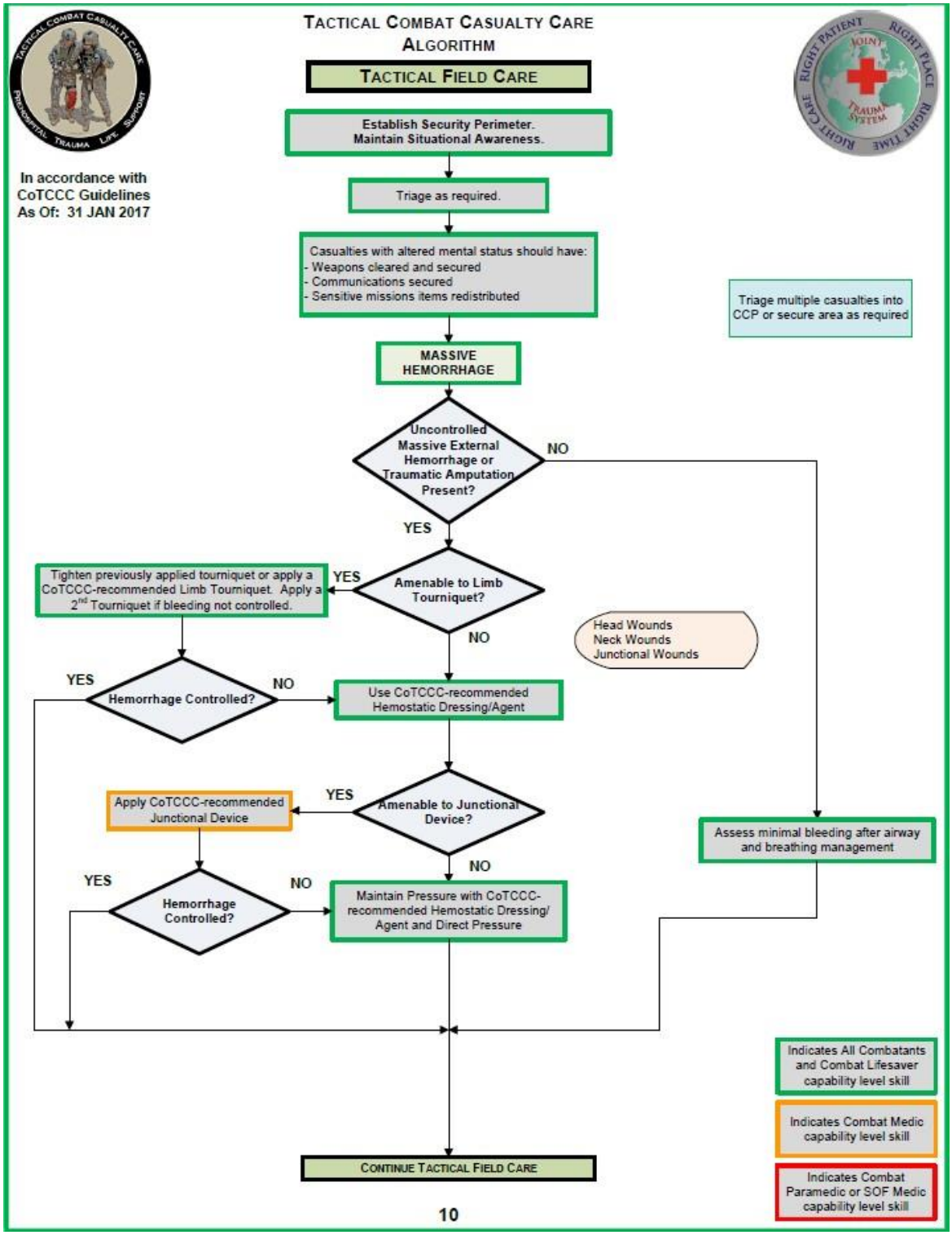
Communication

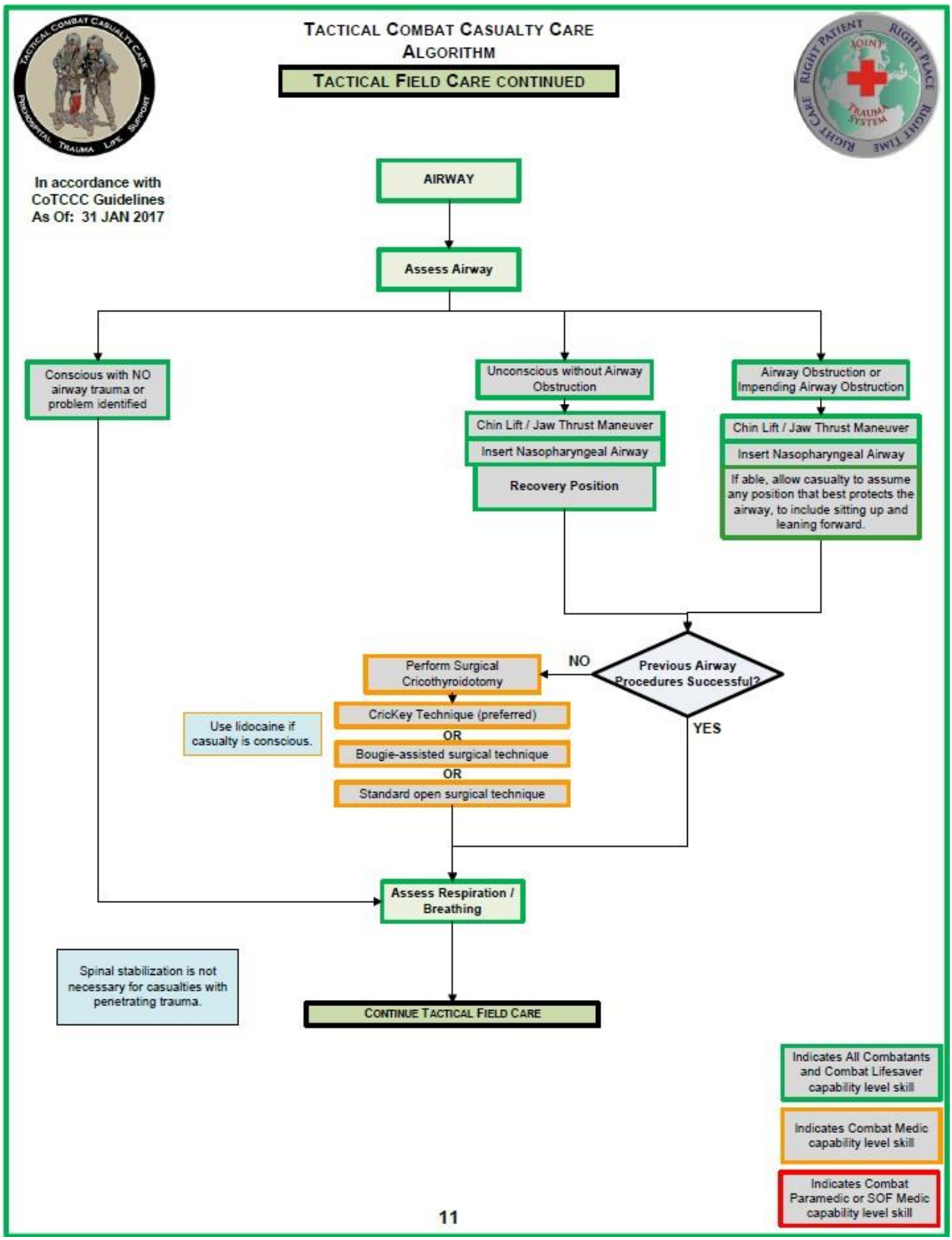
Communicate with the casualty if possible. Encourage, reassure, and explain care
Communicate with next level of care and relay mechanism of injury, injuries sustained, signs/symptoms, and treatments rendered.

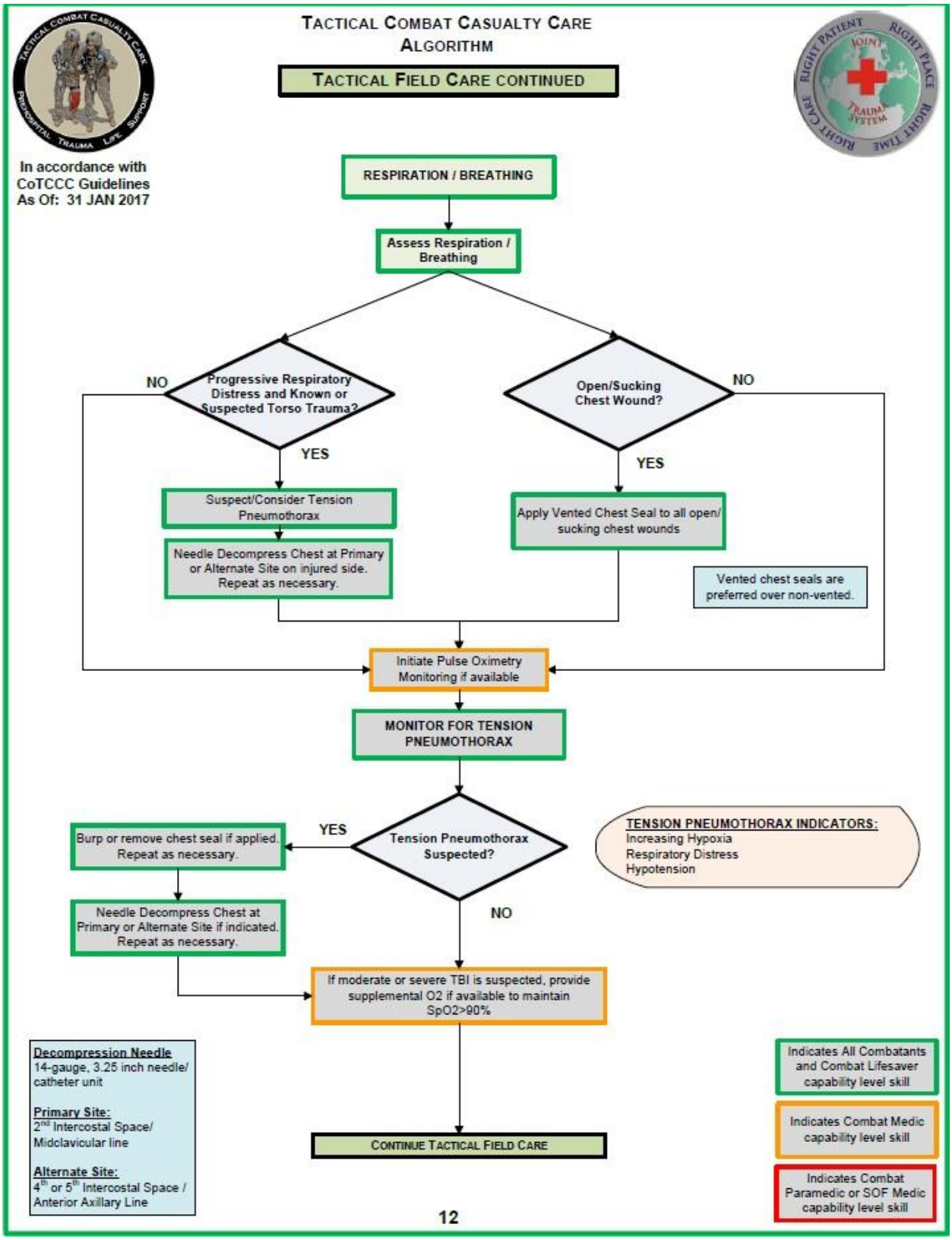
2. Care Under Fire Algorithm

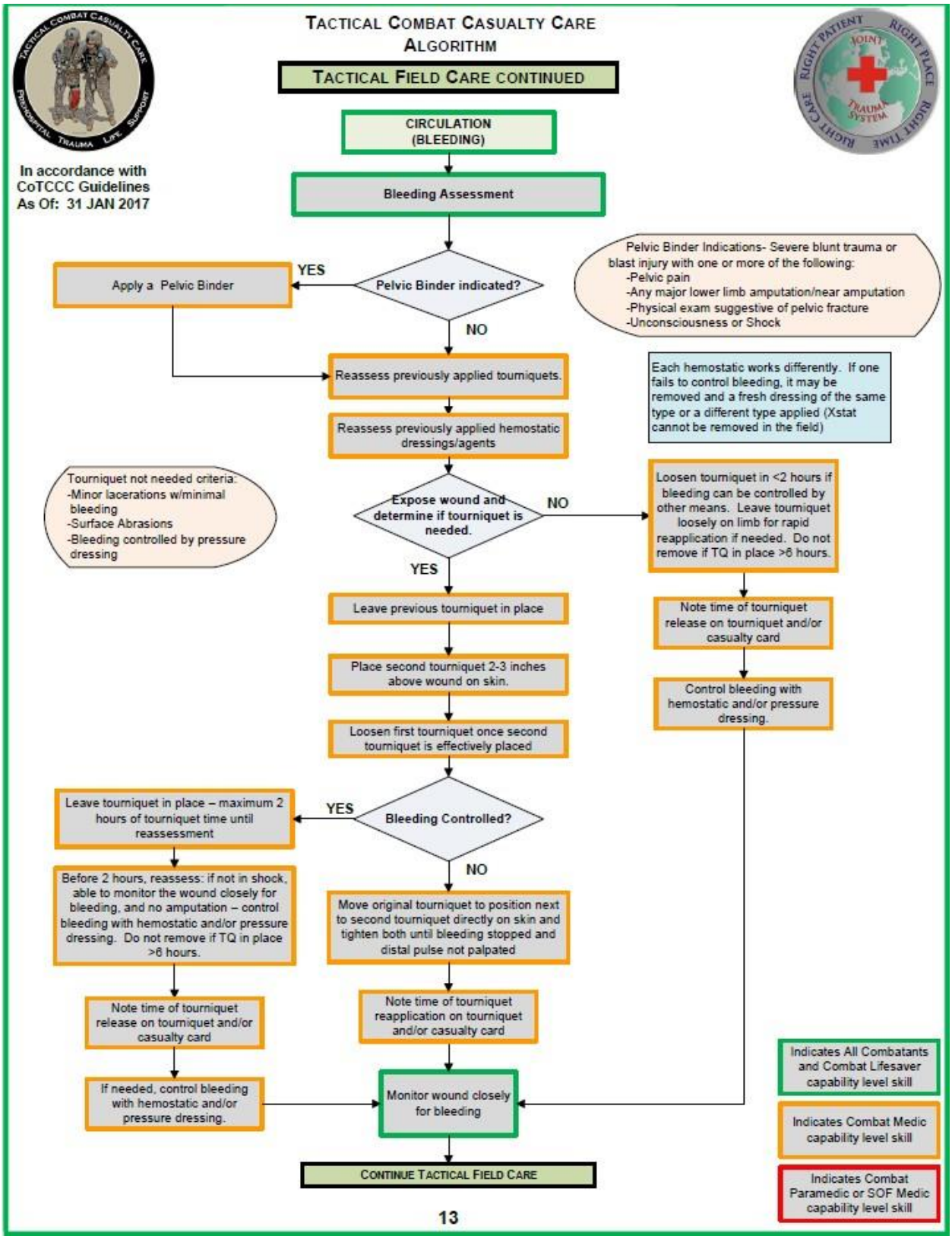

TACTICAL COMBAT CASUALTY CARE ALGORITHM
CARE UNDER FIRE
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
Casualty Sustained
Return Fire and Take Cover
Casualty Conscious?
YES
Direct casualty to move to cover and apply self-aid
NO
Move casualty to cover if tactically feasible
Try to keep casualty from sustaining additional wounds.
Try to keep casualty from sustaining additional wounds.
Casualty moved to cover or extrication needed*
STOP LIFE THREATENING BLEEDING
LIFE THREATENING BLEEDING:
Spurting Blood or Flowing Blood
Blood soaking rapidly through uniform or pooling on the ground
Complete Amputation
Limb Tourniquet Indicated?
YES
Use CoTCCC Recommended Limb Tourniquet applied proximal to bleeding site
NO
* Extrication
-Casualties should be extricated from burning vehicles or buildings and moved to relative safety. Do what is necessary to stop burning process.
Place tourniquets "High & Tight" if bleeding site is not easily identifiable
Continue with Fight / Mission
Casualty Movement:
- The fastest method is dragging along the long axis of patient's body by two rescuers.
-Spinal precautions or stabilization should only be considered after a casualty is removed from the enemy threat and indicated by mechanism of injury.
Airway management is generally best deferred until the Tactical Field Care phase
Move casualty to CCP or secure area and initiate Tactical Field Care
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
TACTICAL FIELD CARE
9

3. Tactical Field Care Algorithm


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
Establish Security Perimeter. Maintain Situational Awareness.
Triage as required.
Casualties with altered mental status should have:
- Weapons cleared and secured
- Communications secured
- Sensitive missions items redistributed
Triage multiple casualties into CCP or secure area as required
MASSIVE HEMORRHAGE
Uncontrolled Massive External Hemorrhage or Traumatic Amputation Present?
NO
YES
Amenable to Limb Tourniquet?
YES
Tighten previously applied tourniquet or apply a CoTCCC-recommended Limb Tourniquet. Apply a 2nd Tourniquet if bleeding not controlled.
NO
Head Wounds
Neck Wounds
Junctional Wounds
Hemorrhage Controlled?
YES
NO
Use CoTCCC-recommended Hemostatic Dressing/Agent
Amenable to Junctional Device?
YES
Apply CoTCCC-recommended Junctional Device
NO
Hemorrhage Controlled?
YES
NO
Maintain Pressure with CoTCCC-recommended Hemostatic Dressing/ Agent and Direct Pressure
Assess minimal bleeding after airway and breathing management
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
10


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
AIRWAY
Assess Airway
Conscious with NO airway trauma or problem identified
Unconscious without Airway Obstruction
Chin Lift / Jaw Thrust Maneuver
Insert Nasopharyngeal Airway
Recovery Position
Airway Obstruction or Impending Airway Obstruction
Chin Lift / Jaw Thrust Maneuver
Insert Nasopharyngeal Airway
If able, allow casualty to assume any position that best protects the airway, to include sitting up and leaning forward.
Previous Airway Procedures Successful?
NO
YES
Perform Surgical Cricothyroidotomy
CricKey Technique (preferred)
OR
Bougie-assisted surgical technique
OR
Standard open surgical technique
Use lidocaine if casualty is conscious.
Assess Respiration / Breathing
Spinal stabilization is not necessary for casualties with penetrating trauma.
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
11


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
RESPIRATION / BREATHING
Assess Respiration / Breathing
Progressive Respiratory Distress and Known or Suspected Torso Trauma?
NO
YES
Suspect/Consider Tension Pneumothorax
Needle Decompress Chest at Primary or Alternate Site on injured side. Repeat as necessary.
Open/Sucking Chest Wound?
NO
YES
Apply Vented Chest Seal to all open/ sucking chest wounds
Vented chest seals are preferred over non-vented.
Initiate Pulse Oximetry Monitoring if available
MONITOR FOR TENSION PNEUMOTHORAX
Tension Pneumothorax Suspected?
YES
Burp or remove chest seal if applied. Repeat as necessary.
Needle Decompress Chest at Primary or Alternate Site if indicated. Repeat as necessary.
NO
TENSION PNEUMOTHORAX INDICATORS:
Increasing Hypoxia
Respiratory Distress
Hypotension
If moderate or severe TBI is suspected, provide supplemental O2 if available to maintain SpO2>90%
CONTINUE TACTICAL FIELD CARE
Decompression Needle
14-gauge, 3.25 inch needle/ catheter unit
Primary Site:
2nd Intercostal Space/ Midclavicular line
Alternate Site:
4th or 5th Intercostal Space / Anterior Axillary Line
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
12


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (BLEEDING)
Bleeding Assessment
Pelvic Binder indicated?
YES
Apply a Pelvic Binder
NO
Pelvic Binder Indications- Severe blunt trauma or blast injury with one or more of the following:
-Pelvic pain
-Any major lower limb amputation/near amputation
-Physical exam suggestive of pelvic fracture
-Unconsciousness or Shock
Reassess previously applied tourniquets.
Reassess previously applied hemostatic dressings/agents
Each hemostatic works differently. If one fails to control bleeding, it may be removed and a fresh dressing of the same type or a different type applied (Xstat cannot be removed in the field)
Tourniquet not needed criteria:
-Minor lacerations w/minimal bleeding
-Surface Abrasions
-Bleeding controlled by pressure dressing
Expose wound and determine if tourniquet is needed.
NO
YES
Loosen tourniquet in <2 hours if bleeding can be controlled by other means. Leave tourniquet loosely on limb for rapid reapplication if needed. Do not remove if TQ in place >6 hours.
Leave previous tourniquet in place
Note time of tourniquet release on tourniquet and/or casualty card
Place second tourniquet 2-3 inches above wound on skin.
Control bleeding with hemostatic and/or pressure dressing.
Loosen first tourniquet once second tourniquet is effectively placed
Bleeding Controlled?
YES
Leave tourniquet in place – maximum 2 hours of tourniquet time until reassessment
NO
Before 2 hours, reassess: if not in shock, able to monitor the wound closely for bleeding, and no amputation – control bleeding with hemostatic and/or pressure dressing. Do not remove if TQ in place >6 hours.
Move original tourniquet to position next to second tourniquet directly on skin and tighten both until bleeding stopped and distal pulse not palpated
Note time of tourniquet release on tourniquet and/or casualty card
Note time of tourniquet reapplication on tourniquet and/or casualty card
If needed, control bleeding with hemostatic and/or pressure dressing.
Monitor wound closely for bleeding
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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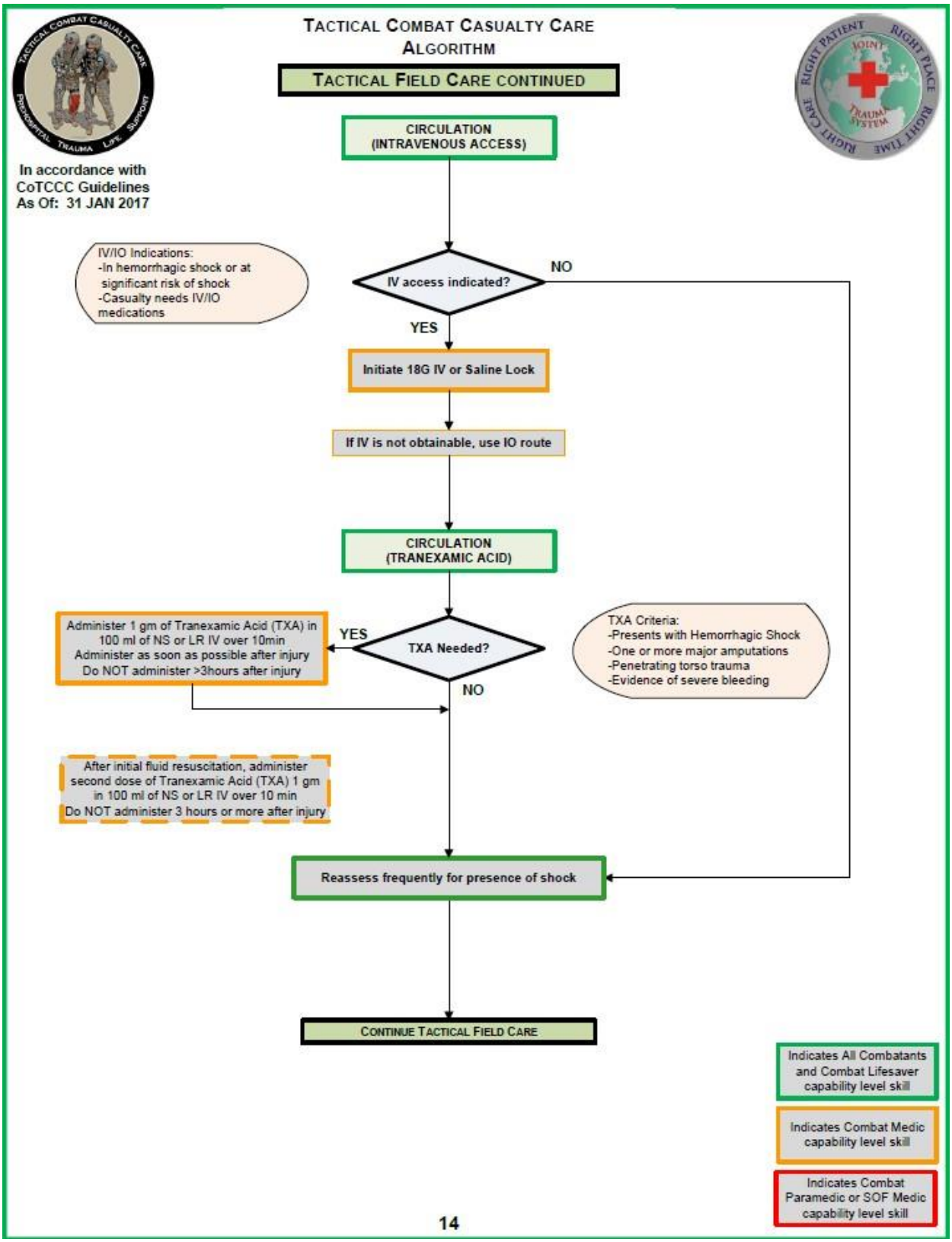
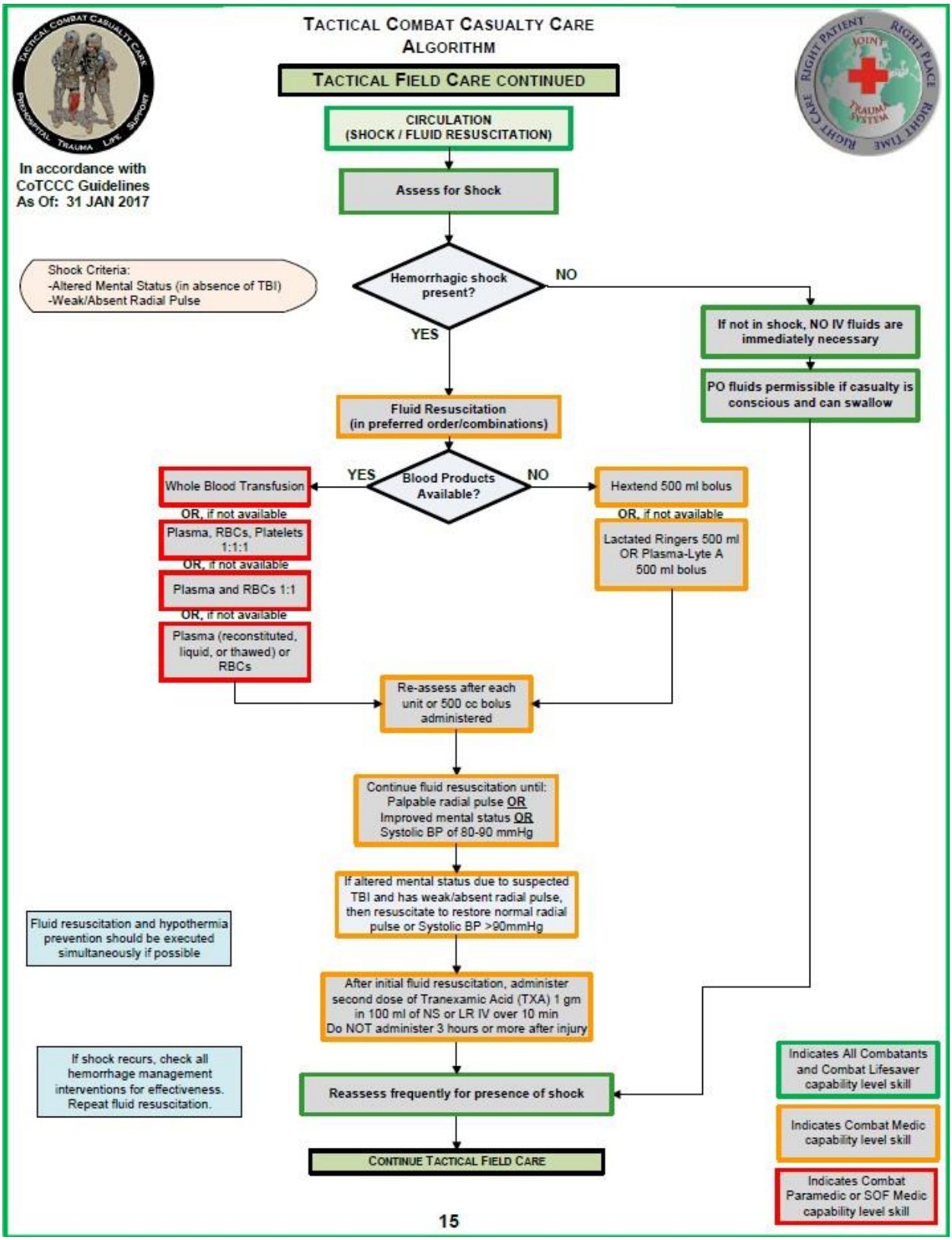
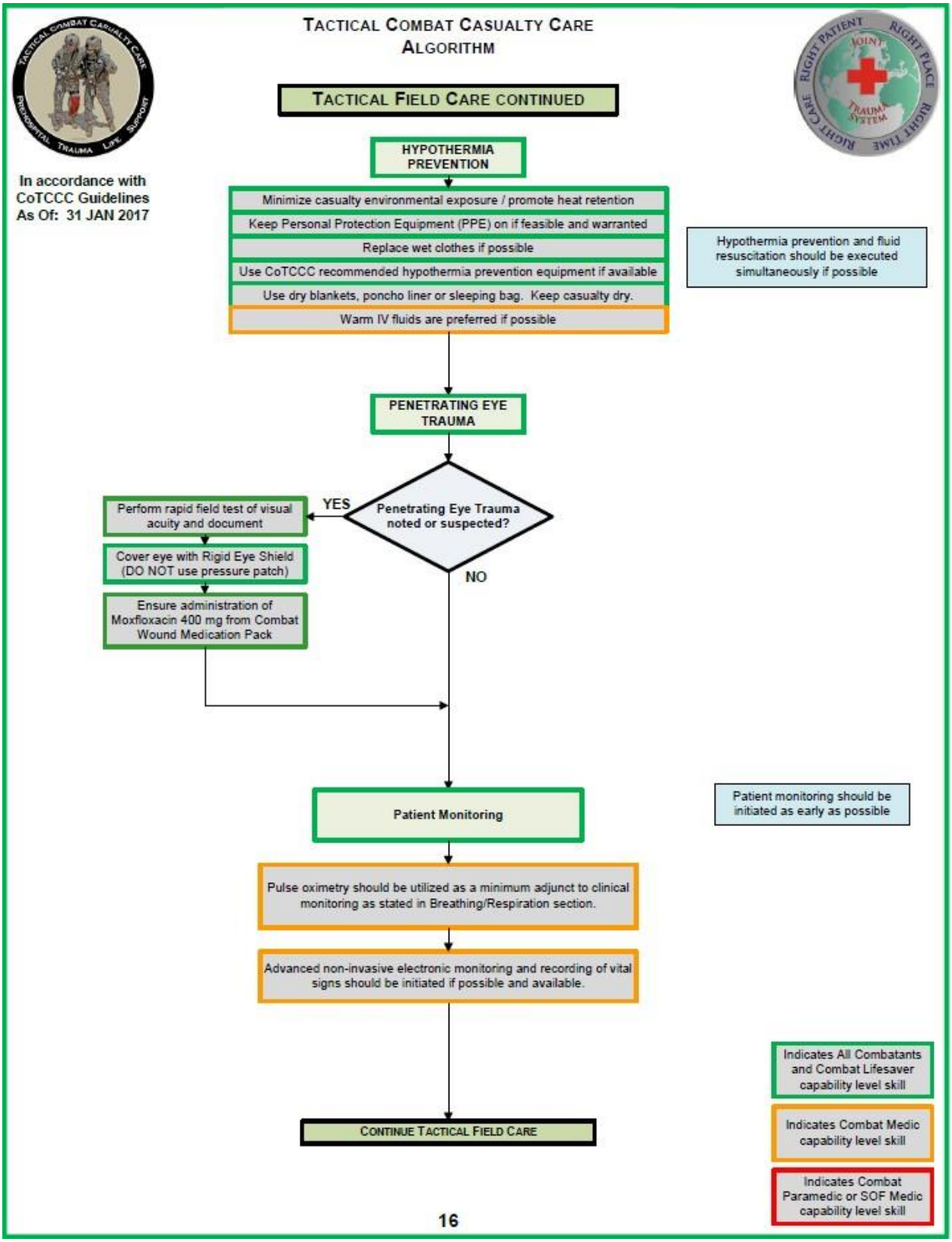
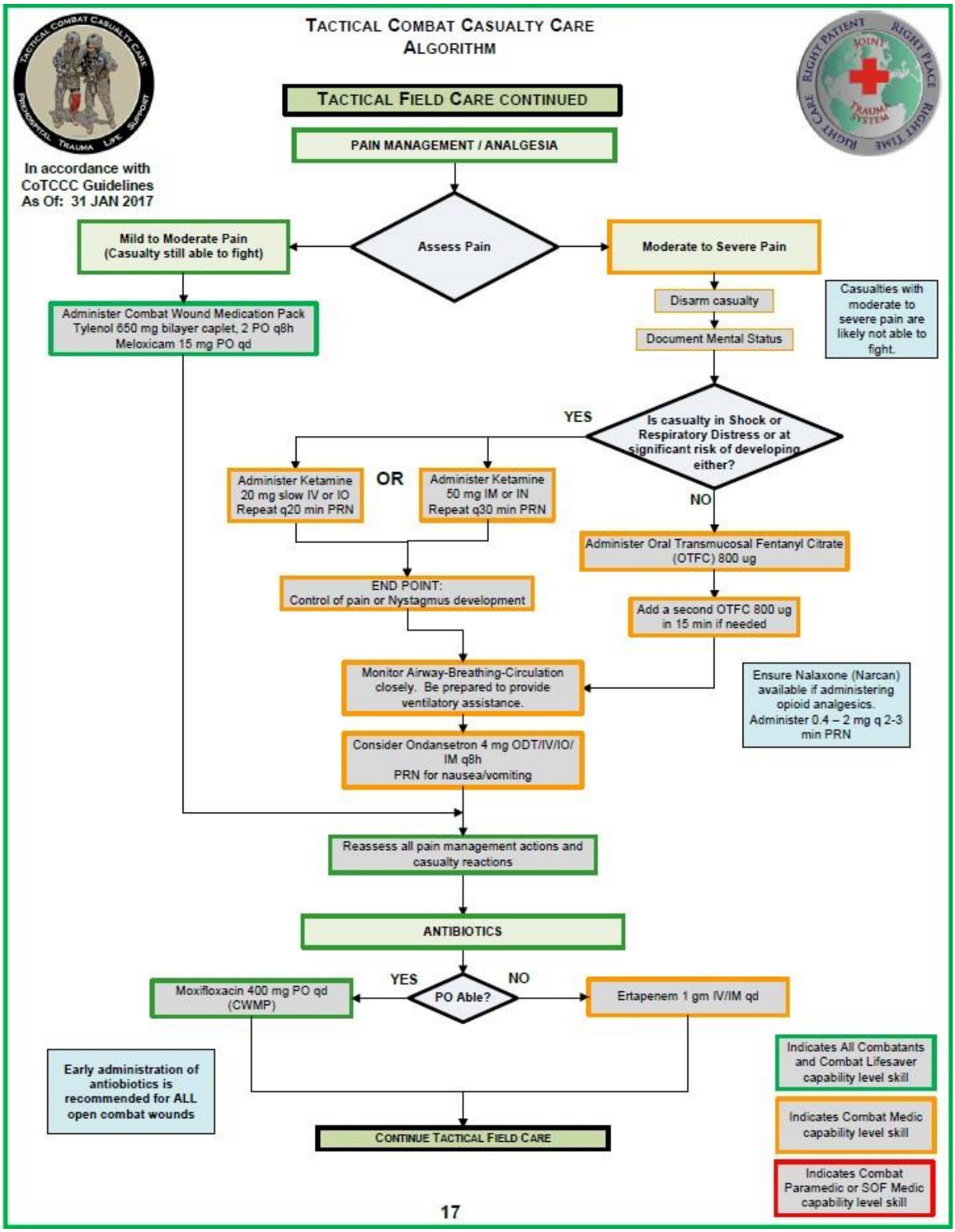

TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (INTRAVENOUS ACCESS)
IV/IO Indications:
-In hemorrhagic shock or at significant risk of shock
-Casualty needs IV/IO medications
IV access indicated?
NO
YES
Initiate 18G IV or Saline Lock
If IV is not obtainable, use IO route
CIRCULATION (TRANEXAMIC ACID)
Administer 1 gm of Tranexamic Acid (TXA) in 100 ml of NS or LR IV over 10min
Administer as soon as possible after injury
Do NOT administer >3hours after injury
YES
TXA Needed?
NO
TXA Criteria:
-Presents with Hemorrhagic Shock
-One or more major amputations
-Penetrating torso trauma
-Evidence of severe bleeding
After initial fluid resuscitation, administer second dose of Tranexamic Acid (TXA) 1 gm in 100 ml of NS or LR IV over 10 min
Do NOT administer 3 hours or more after injury
Reassess frequently for presence of shock
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
14


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (SHOCK / FLUID RESUSCITATION)
Assess for Shock
Shock Criteria:
-Altered Mental Status (in absence of TBI)
-Weak/Absent Radial Pulse
Hemorrhagic shock present?
NO
YES
If not in shock, NO IV fluids are immediately necessary
PO fluids permissible if casualty is conscious and can swallow
Fluid Resuscitation (in preferred order/combinations)
Blood Products Available?
YES
NO
Whole Blood Transfusion
OR, if not available
Plasma, RBCs, Platelets 1:1:1
OR, if not available
Plasma and RBCs 1:1
OR, if not available
Plasma (reconstituted, liquid, or thawed) or RBCs
Hextend 500 ml bolus
OR, if not available
Lactated Ringers 500 ml OR Plasma-Lyte A 500 ml bolus
Re-assess after each unit or 500 cc bolus administered
Continue fluid resuscitation until: Palpable radial pulse OR Improved mental status OR Systolic BP of 80-90 mmHg
If altered mental status due to suspected TBI and has weak/absent radial pulse, then resuscitate to restore normal radial pulse or Systolic BP >90mmHg
Fluid resuscitation and hypothermia prevention should be executed simultaneously if possible
After initial fluid resuscitation, administer second dose of Tranexamic Acid (TXA) 1 gm in 100 ml of NS or LR IV over 10 min Do NOT administer 3 hours or more after injury
If shock recurs, check all hemorrhage management interventions for effectiveness. Repeat fluid resuscitation.
Reassess frequently for presence of shock
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
15


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
HYPOTHERMIA PREVENTION
Minimize casualty environmental exposure / promote heat retention
Keep Personal Protection Equipment (PPE) on if feasible and warranted
Replace wet clothes if possible
Use CoTCCC recommended hypothermia prevention equipment if available
Use dry blankets, poncho liner or sleeping bag. Keep casualty dry.
Warm IV fluids are preferred if possible
Hypothermia prevention and fluid resuscitation should be executed simultaneously if possible
PENETRATING EYE TRAUMA
Penetrating Eye Trauma noted or suspected?
YES
Perform rapid field test of visual acuity and document
Cover eye with Rigid Eye Shield (DO NOT use pressure patch)
Ensure administration of Moxfloxacin 400 mg from Combat Wound Medication Pack
NO
Patient Monitoring
Patient monitoring should be initiated as early as possible
Pulse oximetry should be utilized as a minimum adjunct to clinical monitoring as stated in Breathing/Respiration section.
Advanced non-invasive electronic monitoring and recording of vital signs should be initiated if possible and available.
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
16


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
PAIN MANAGEMENT / ANALGESIA
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
Assess Pain
Mild to Moderate Pain (Casualty still able to fight)
Moderate to Severe Pain
Administer Combat Wound Medication Pack Tylenol 650 mg bilayer caplet, 2 PO q8h Meloxicam 15 mg PO qd
Disarm casualty
Document Mental Status
Casualties with moderate to severe pain are likely not able to fight.
YES
Is casualty in Shock or Respiratory Distress or at significant risk of developing either?
NO
Administer Ketamine 20 mg slow IV or IO Repeat q20 min PRN
OR
Administer Ketamine 50 mg IM or IN Repeat q30 min PRN
Administer Oral Transmucosal Fentanyl Citrate (OTFC) 800 ug
END POINT: Control of pain or Nystagmus development
Add a second OTFC 800 ug in 15 min if needed
Monitor Airway-Breathing-Circulation closely. Be prepared to provide ventilatory assistance.
Ensure Nalaxone (Narcan) available if administering opioid analgesics. Administer 0.4 – 2 mg q 2-3 min PRN
Consider Ondansetron 4 mg ODT/IV/IO/ IM q8h PRN for nausea/vomiting
Reassess all pain management actions and casualty reactions
ANTIBIOTICS
YES
PO Able?
NO
Moxifloxacin 400 mg PO qd (CWMP)
Ertapenem 1 gm IV/IM qd
Early administration of antiobiotics is recommended for ALL open combat wounds
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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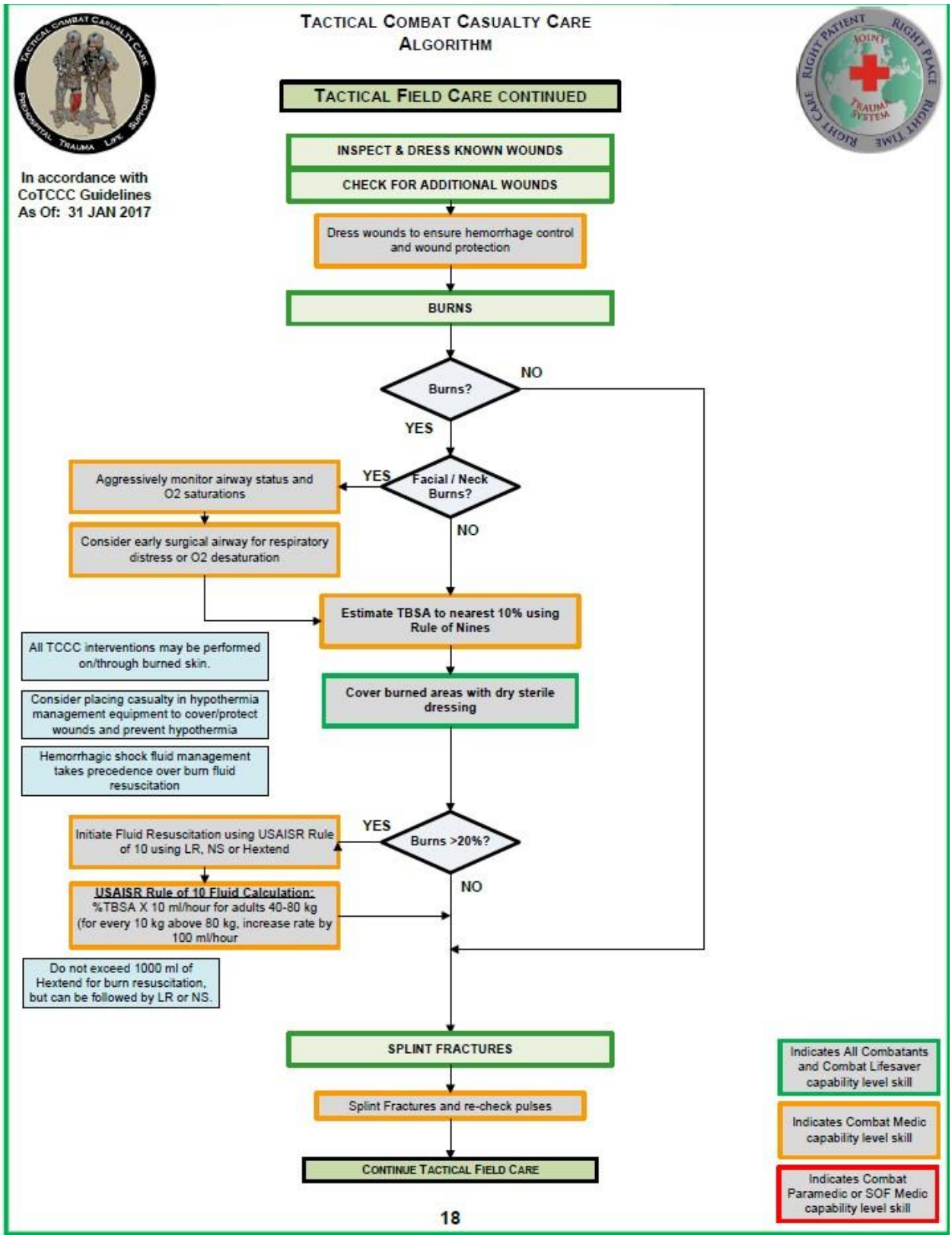
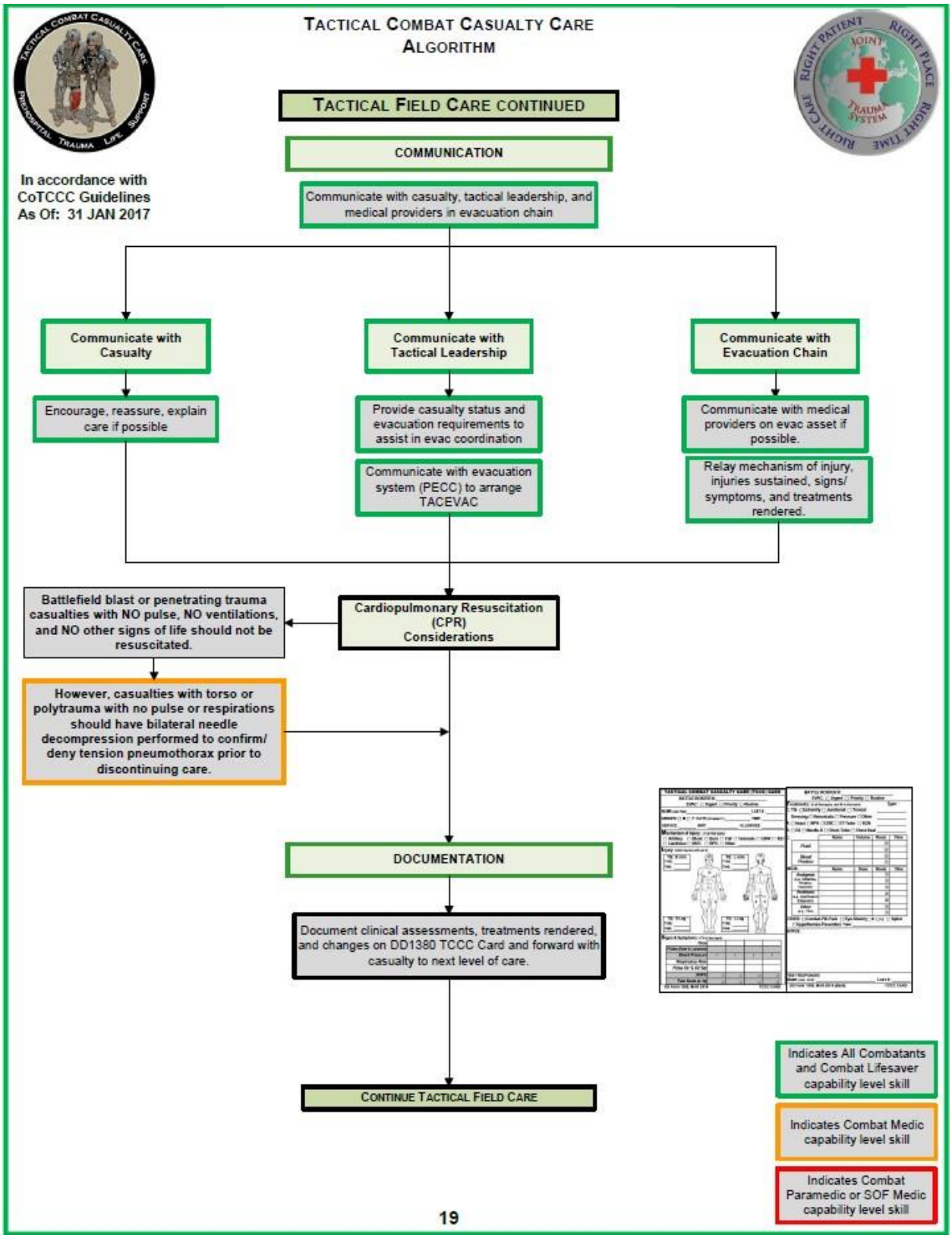
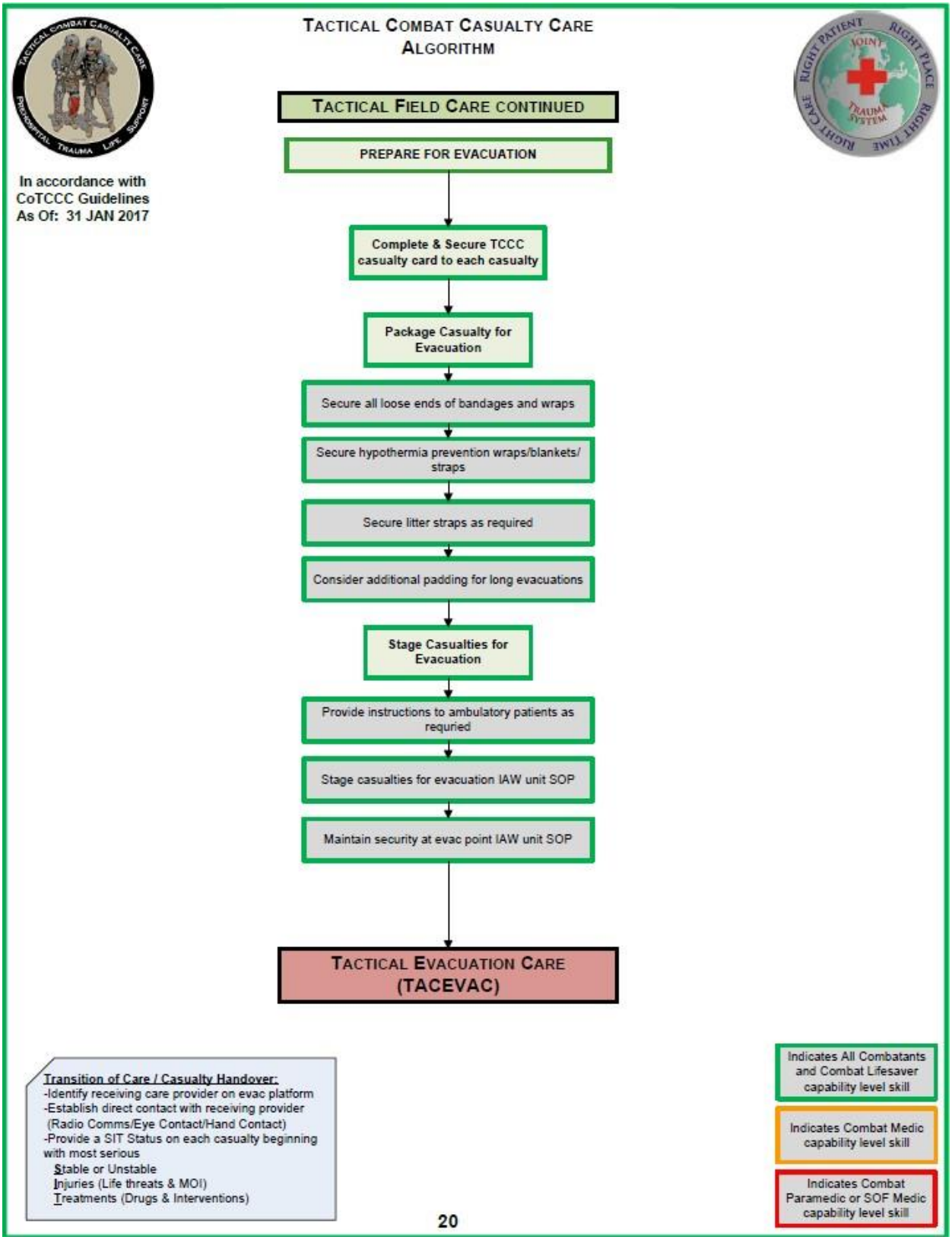

TACTICAL COMBAT CASUALTY CARE ALGORITHM
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
TACTICAL FIELD CARE CONTINUED
INSPECT & DRESS KNOWN WOUNDS
CHECK FOR ADDITIONAL WOUNDS
Dress wounds to ensure hemorrhage control and wound protection
BURNS
Burns?
NO
YES
Facial / Neck Burns?
YES
Aggressively monitor airway status and O2 saturations
Consider early surgical airway for respiratory distress or O2 desaturation
NO
Estimate TBSA to nearest 10% using Rule of Nines
All TCCC interventions may be performed on/through burned skin.
Consider placing casualty in hypothermia management equipment to cover/protect wounds and prevent hypothermia
Hemorrhagic shock fluid management takes precedence over burn fluid resuscitation
Cover burned areas with dry sterile dressing
Burns >20%?
YES
Initiate Fluid Resuscitation using USAISR Rule of 10 using LR, NS or Hextend
NO
USAISR Rule of 10 Fluid Calculation:
%TBSA X 10 ml/hour for adults 40-80 kg
(for every 10 kg above 80 kg, increase rate by 100 ml/hour
Do not exceed 1000 ml of Hextend for burn resuscitation, but can be followed by LR or NS.
SPLINT FRACTURES
Splint Fractures and re-check pulses
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
18


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL FIELD CARE CONTINUED
COMMUNICATION
Communicate with casualty, tactical leadership, and medical providers in evacuation chain
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
Communicate with Casualty
Encourage, reassure, explain care if possible
Communicate with Tactical Leadership
Provide casualty status and evacuation requirements to assist in evac coordination
Communicate with evacuation system (PECC) to arrange TACEVAC
Communicate with Evacuation Chain
Communicate with medical providers on evac asset if possible.
Relay mechanism of injury, injuries sustained, signs/ symptoms, and treatments rendered.
Cardiopulmonary Resuscitation (CPR) Considerations
Battlefield blast or penetrating trauma casualties with NO pulse, NO ventilations, and NO other signs of life should not be resuscitated.
However, casualties with torso or polytrauma with no pulse or respirations should have bilateral needle decompression performed to confirm/ deny tension pneumothorax prior to discontinuing care.
DOCUMENTATION
Document clinical assessments, treatments rendered, and changes on DD1380 TCCC Card and forward with casualty to next level of care.
CONTINUE TACTICAL FIELD CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
19


TACTICAL COMBAT CASUALTY CARE ALGORITHM
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
TACTICAL FIELD CARE CONTINUED
PREPARE FOR EVACUATION
Complete & Secure TCCC casualty card to each casualty
Package Casualty for Evacuation
Secure all loose ends of bandages and wraps
Secure hypothermia prevention wraps/blankets/ straps
Secure litter straps as required
Consider additional padding for long evacuations
Stage Casualties for Evacuation
Provide instructions to ambulatory patients as requried
Stage casualties for evacuation IAW unit SOP
Maintain security at evac point IAW unit SOP
TACTICAL EVACUATION CARE (TACEVAC)
Transition of Care / Casualty Handover:
-Identify receiving care provider on evac platform
-Establish direct contact with receiving provider (Radio Comms/Eye Contact/Hand Contact)
-Provide a SIT Status on each casualty beginning with most serious
Stable or Unstable
Injuries (Life threats & MOI)
Treatments (Drugs & Interventions)
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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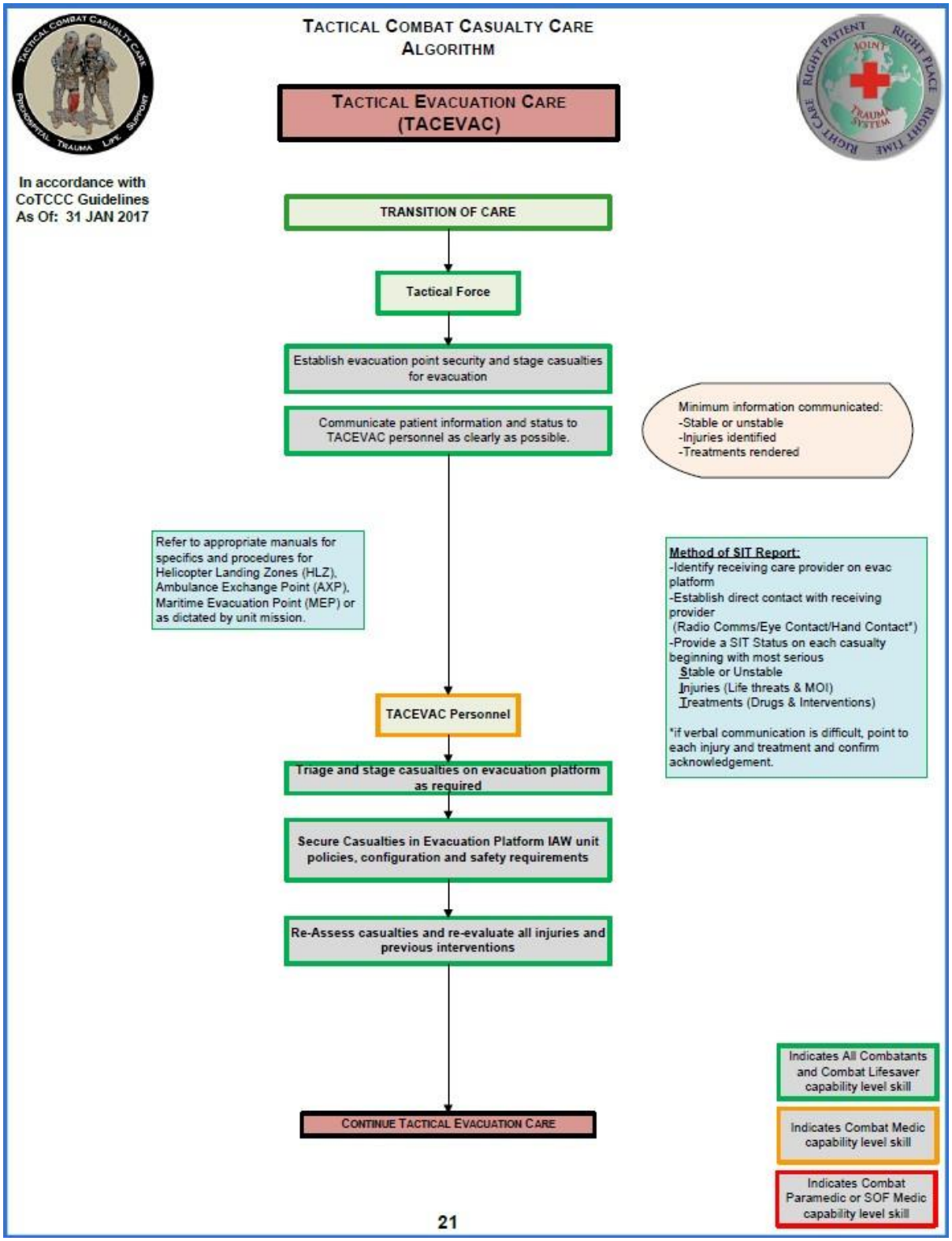
VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

4. Tactical Evacuation Care Algorithm


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
TRANSITION OF CARE
Tactical Force
Establish evacuation point security and stage casualties for evacuation
Communicate patient information and status to TACEVAC personnel as clearly as possible.
Minimum information communicated:
-Stable or unstable
-Injuries identified
-Treatments rendered
Refer to appropriate manuals for specifics and procedures for Helicopter Landing Zones (HLZ), Ambulance Exchange Point (AXP), Maritime Evacuation Point (MEP) or as dictated by unit mission.
Method of SIT Report:
-Identify receiving care provider on evac platform
-Establish direct contact with receiving provider
(Radio Comms/Eye Contact/Hand Contact*)
-Provide a SIT Status on each casualty beginning with most serious
Stable or Unstable
Injuries (Life threats & MOI)
Treatments (Drugs & Interventions)
*if verbal communication is difficult, point to each injury and treatment and confirm acknowledgement.
TACEVAC Personnel
Triage and stage casualties on evacuation platform as required
Secure Casualties in Evacuation Platform IAW unit policies, configuration and safety requirements
Re-Assess casualties and re-evaluate all injuries and previous interventions
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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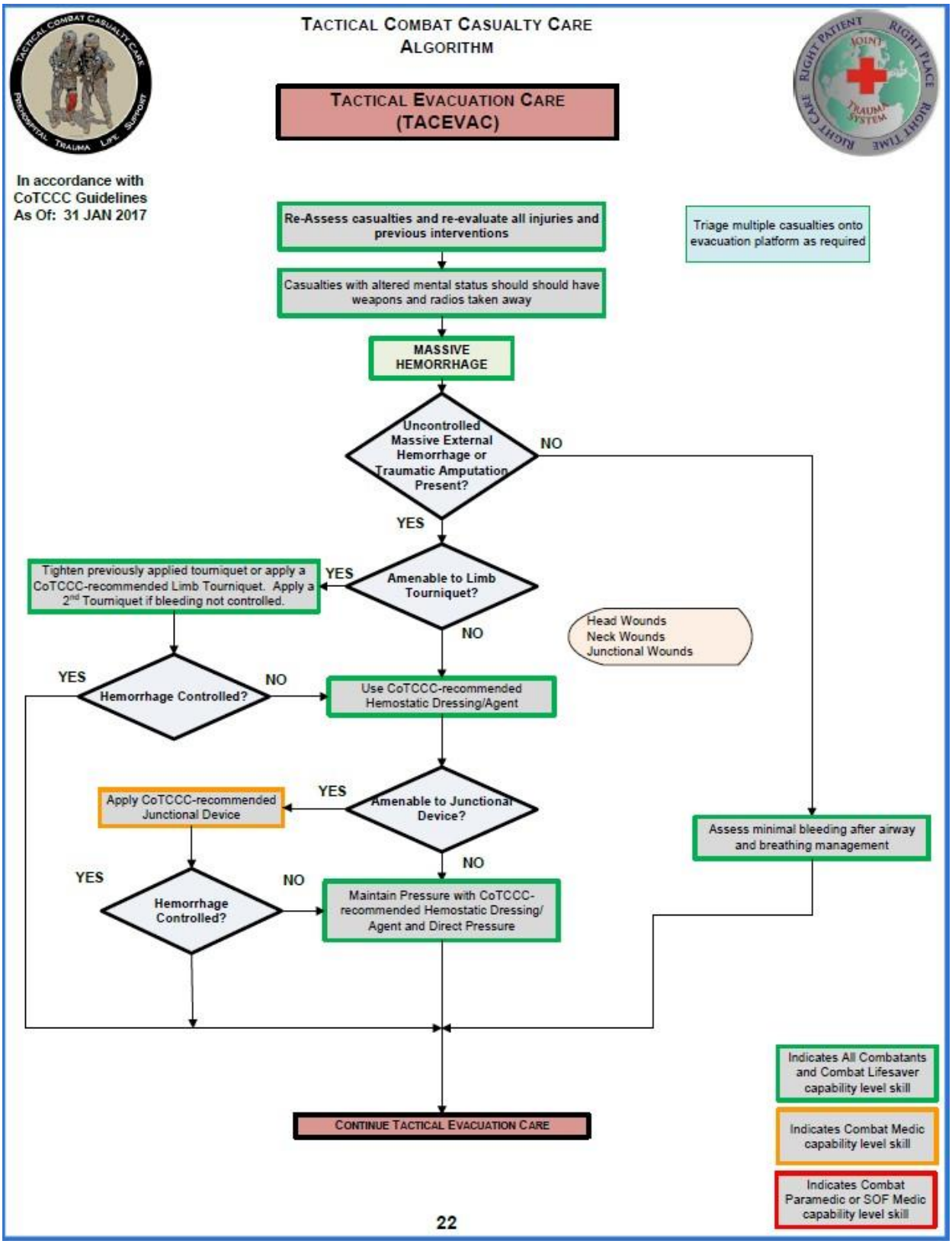
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
Re-Assess casualties and re-evaluate all injuries and previous interventions
Triage multiple casualties onto evacuation platform as required
Casualties with altered mental status should should have weapons and radios taken away
MASSIVE HEMORRHAGE
Uncontrolled Massive External Hemorrhage or Traumatic Amputation Present?
NO
YES
Amenable to Limb Tourniquet?
YES
Tighten previously applied tourniquet or apply a CoTCCC-recommended Limb Tourniquet. Apply a 2nd Tourniquet if bleeding not controlled.
NO
Head Wounds
Neck Wounds
Junctional Wounds
Hemorrhage Controlled?
YES
NO
Use CoTCCC-recommended Hemostatic Dressing/Agent
Amenable to Junctional Device?
YES
Apply CoTCCC-recommended Junctional Device
NO
Hemorrhage Controlled?
YES
NO
Maintain Pressure with CoTCCC-recommended Hemostatic Dressing/ Agent and Direct Pressure
Assess minimal bleeding after airway and breathing management
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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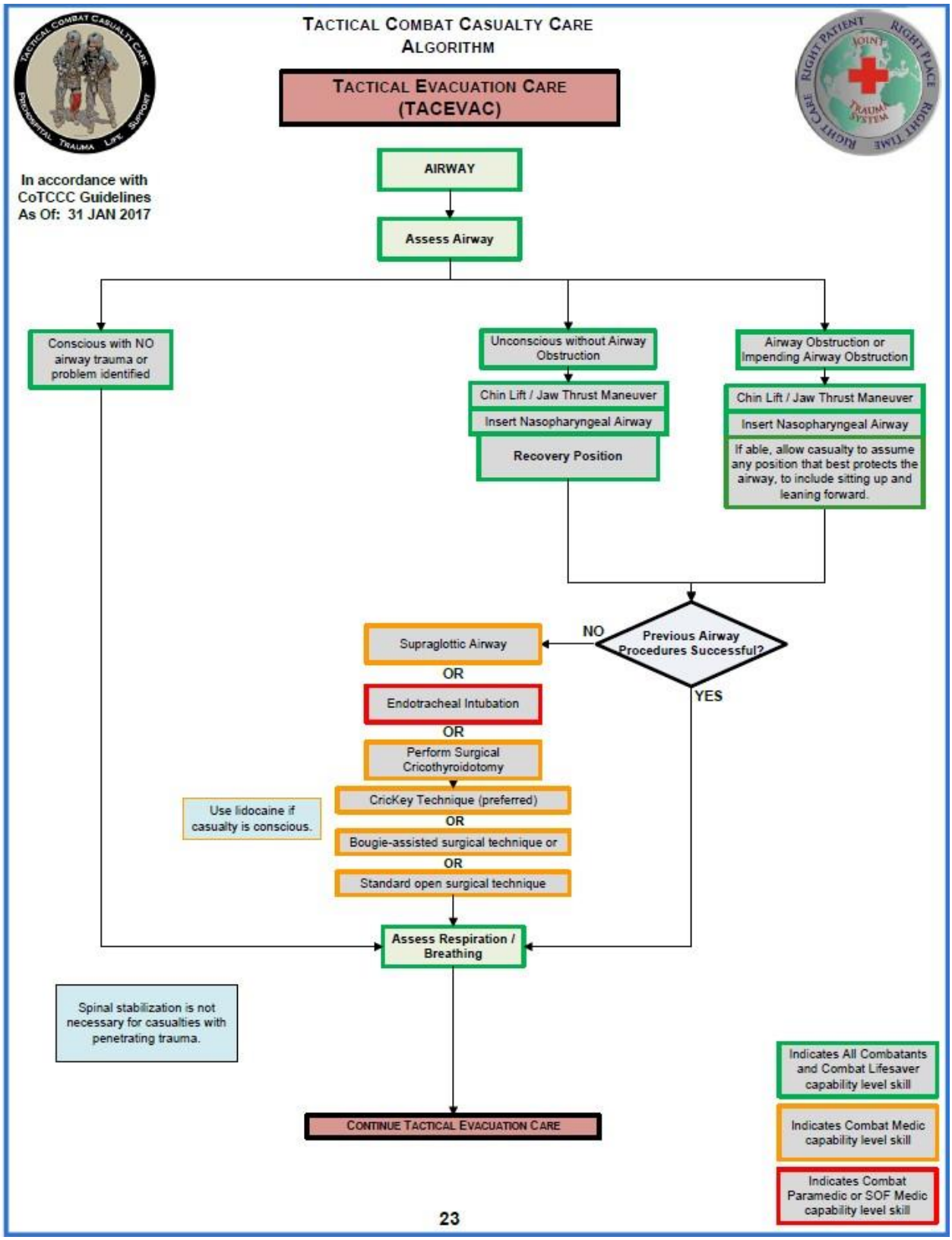
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
AIRWAY
Assess Airway
Conscious with NO airway trauma or problem identified
Unconscious without Airway Obstruction
Chin Lift / Jaw Thrust Maneuver
Insert Nasopharyngeal Airway
Recovery Position
Airway Obstruction or Impending Airway Obstruction
Chin Lift / Jaw Thrust Maneuver
Insert Nasopharyngeal Airway
If able, allow casualty to assume any position that best protects the airway, to include sitting up and leaning forward.
Previous Airway Procedures Successful?
NO
YES
Supraglottic Airway
OR
Endotracheal Intubation
OR
Perform Surgical Cricothyroidotomy
CricKey Technique (preferred)
OR
Bougie-assisted surgical technique or
OR
Standard open surgical technique
Use lidocaine if casualty is conscious.
Assess Respiration / Breathing
Spinal stabilization is not necessary for casualties with penetrating trauma.
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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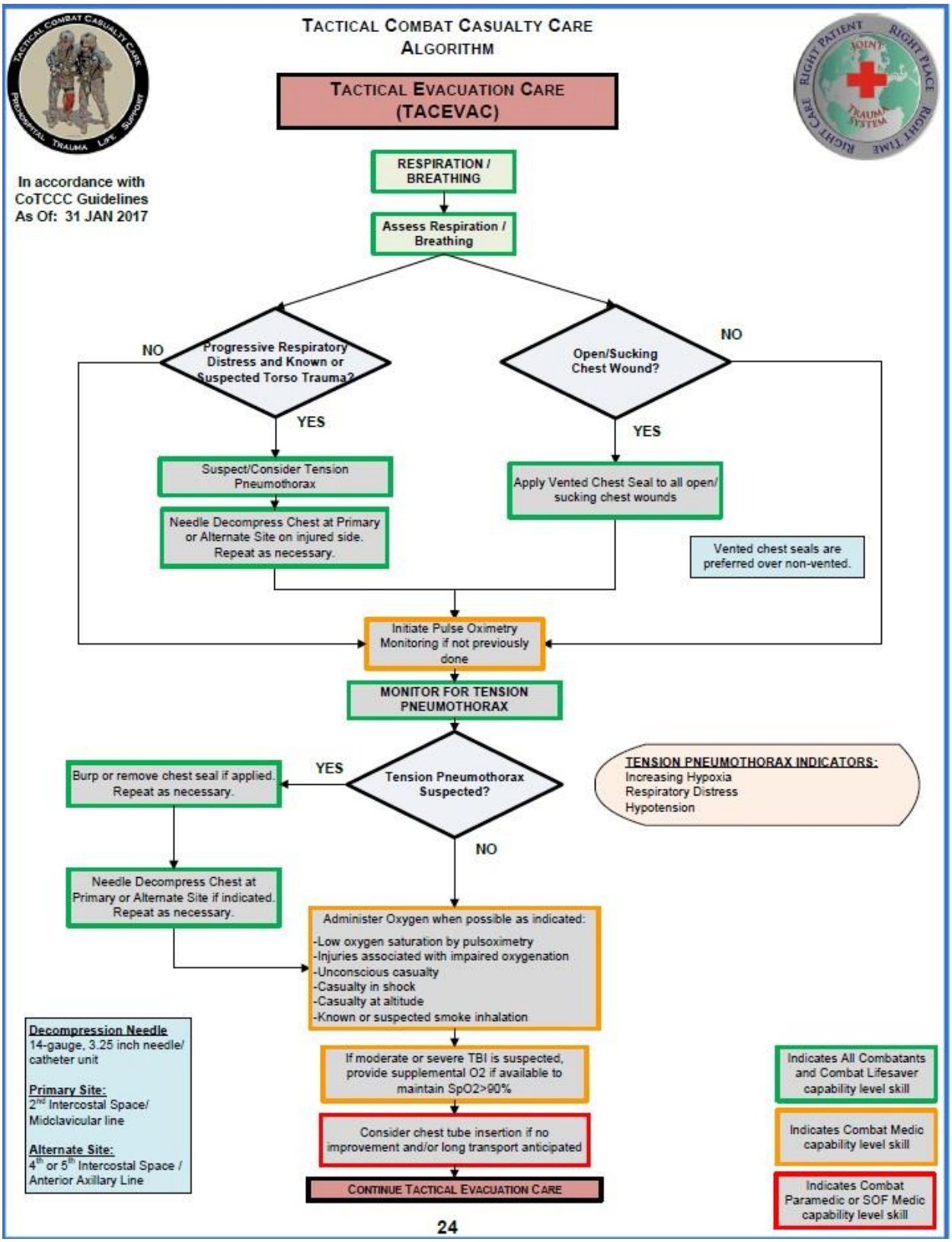
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
RESPIRATION / BREATHING
Assess Respiration / Breathing
Progressive Respiratory Distress and Known or Suspected Torso Trauma?
NO
YES
Suspect/Consider Tension Pneumothorax
Needle Decompress Chest at Primary or Alternate Site on injured side. Repeat as necessary.
Open/Sucking Chest Wound?
NO
YES
Apply Vented Chest Seal to all open/ sucking chest wounds
Vented chest seals are preferred over non-vented.
Initiate Pulse Oximetry Monitoring if not previously done
MONITOR FOR TENSION PNEUMOTHORAX
Tension Pneumothorax Suspected?
YES
Burp or remove chest seal if applied. Repeat as necessary.
Needle Decompress Chest at Primary or Alternate Site if indicated. Repeat as necessary.
NO
TENSION PNEUMOTHORAX INDICATORS:
Increasing Hypoxia
Respiratory Distress
Hypotension
Administer Oxygen when possible as indicated:
-Low oxygen saturation by pulsoximetry
-Injuries associated with impaired oxygenation
-Unconscious casualty
-Casualty in shock
-Casualty at altitude
-Known or suspected smoke inhalation
If moderate or severe TBI is suspected, provide supplemental O2 if available to maintain SpO2>90%
Consider chest tube insertion if no improvement and/or long transport anticipated
CONTINUE TACTICAL EVACUATION CARE
Decompression Needle
14-gauge, 3.25 inch needle/ catheter unit
Primary Site:
2nd Intercostal Space/ Midclavicular line
Alternate Site:
4th or 5th Intercostal Space / Anterior Axillary Line
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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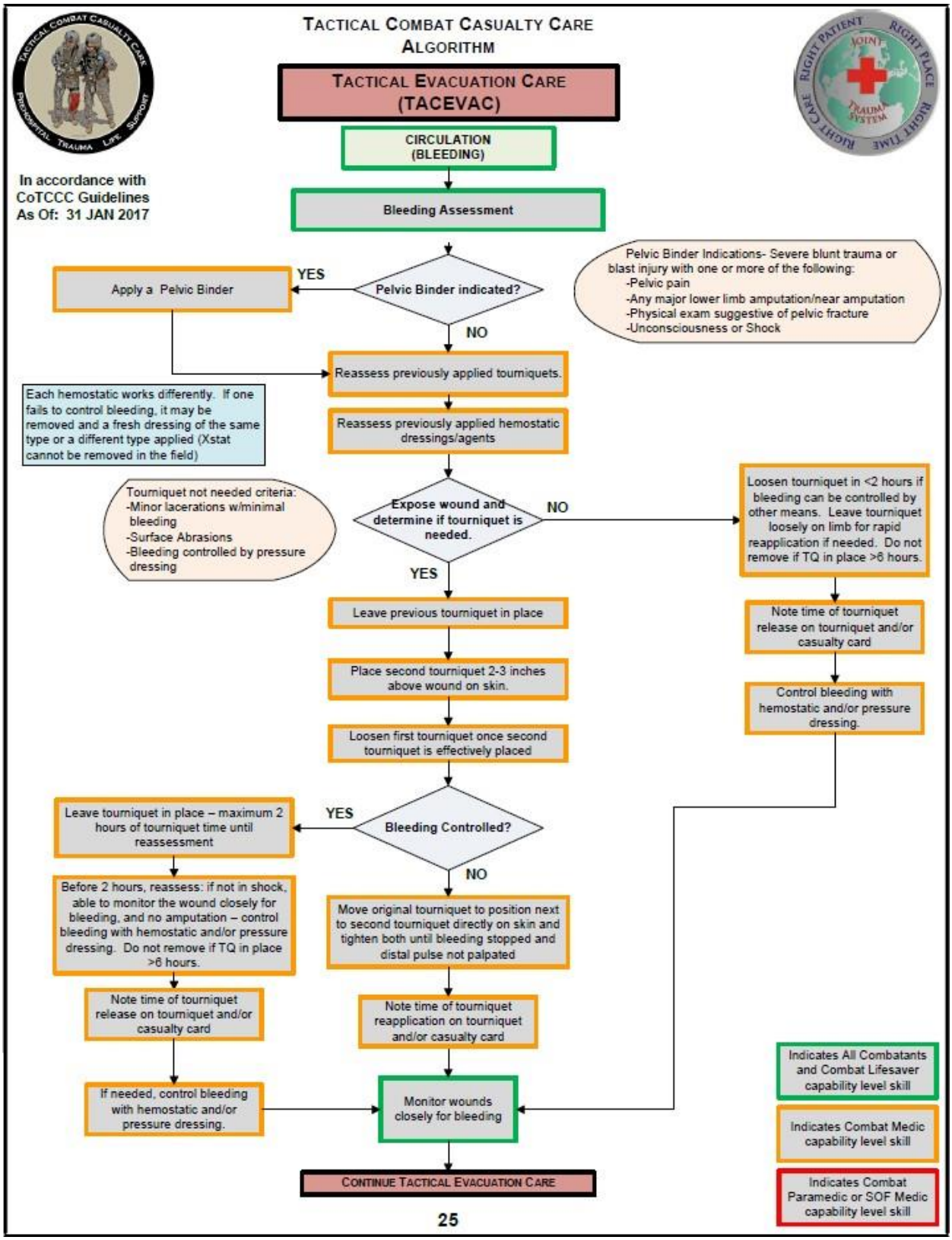
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (BLEEDING)
Bleeding Assessment
Pelvic Binder indicated?
YES
Apply a Pelvic Binder
NO
Pelvic Binder Indications- Severe blunt trauma or blast injury with one or more of the following:
-Pelvic pain
-Any major lower limb amputation/near amputation
-Physical exam suggestive of pelvic fracture
-Unconsciousness or Shock
Reassess previously applied tourniquets.
Each hemostatic works differently. If one fails to control bleeding, it may be removed and a fresh dressing of the same type or a different type applied (Xstat cannot be removed in the field)
Reassess previously applied hemostatic dressings/agents
Tourniquet not needed criteria:
-Minor lacerations w/minimal bleeding
-Surface Abrasions
-Bleeding controlled by pressure dressing
Expose wound and determine if tourniquet is needed.
NO
Loosen tourniquet in <2 hours if bleeding can be controlled by other means. Leave tourniquet loosely on limb for rapid reapplication if needed. Do not remove if TQ in place >6 hours.
YES
Leave previous tourniquet in place
Note time of tourniquet release on tourniquet and/or casualty card
Place second tourniquet 2-3 inches above wound on skin.
Control bleeding with hemostatic and/or pressure dressing.
Loosen first tourniquet once second tourniquet is effectively placed
Leave tourniquet in place – maximum 2 hours of tourniquet time until reassessment
YES
Bleeding Controlled?
NO
Before 2 hours, reassess: if not in shock, able to monitor the wound closely for bleeding, and no amputation – control bleeding with hemostatic and/or pressure dressing. Do not remove if TQ in place >6 hours.
Move original tourniquet to position next to second tourniquet directly on skin and tighten both until bleeding stopped and distal pulse not palpated
Note time of tourniquet release on tourniquet and/or casualty card
Note time of tourniquet reapplication on tourniquet and/or casualty card
If needed, control bleeding with hemostatic and/or pressure dressing.
Monitor wounds closely for bleeding
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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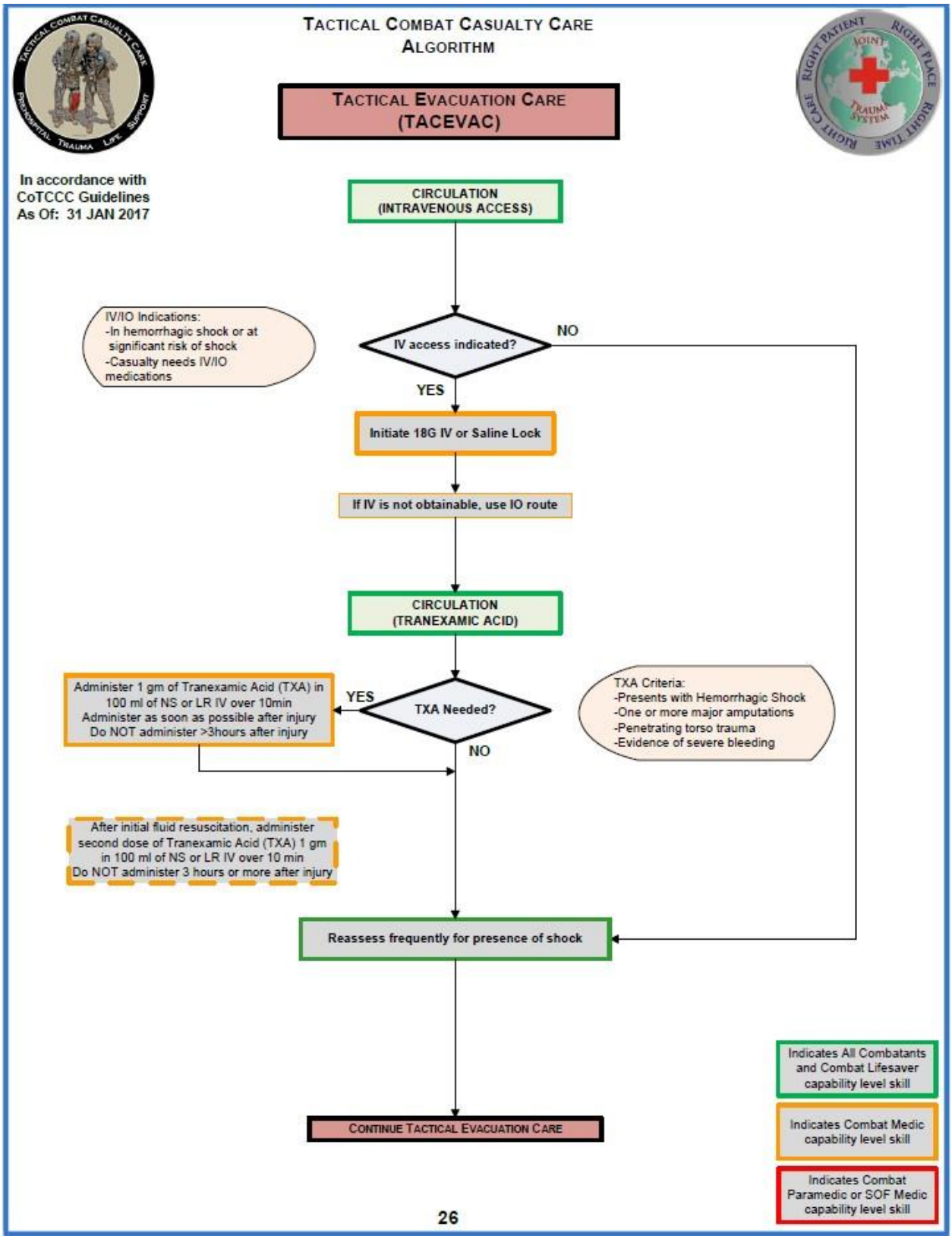
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (INTRAVENOUS ACCESS)
IV/IO Indications:
-In hemorrhagic shock or at significant risk of shock
-Casualty needs IV/IO medications
IV access indicated?
NO
YES
Initiate 18G IV or Saline Lock
If IV is not obtainable, use IO route
CIRCULATION (TRANEXAMIC ACID)
Administer 1 gm of Tranexamic Acid (TXA) in 100 ml of NS or LR IV over 10min
Administer as soon as possible after injury
Do NOT administer >3hours after injury
YES
TXA Needed?
NO
TXA Criteria:
-Presents with Hemorrhagic Shock
-One or more major amputations
-Penetrating torso trauma
-Evidence of severe bleeding
After initial fluid resuscitation, administer second dose of Tranexamic Acid (TXA) 1 gm in 100 ml of NS or LR IV over 10 min
Do NOT administer 3 hours or more after injury
Reassess frequently for presence of shock
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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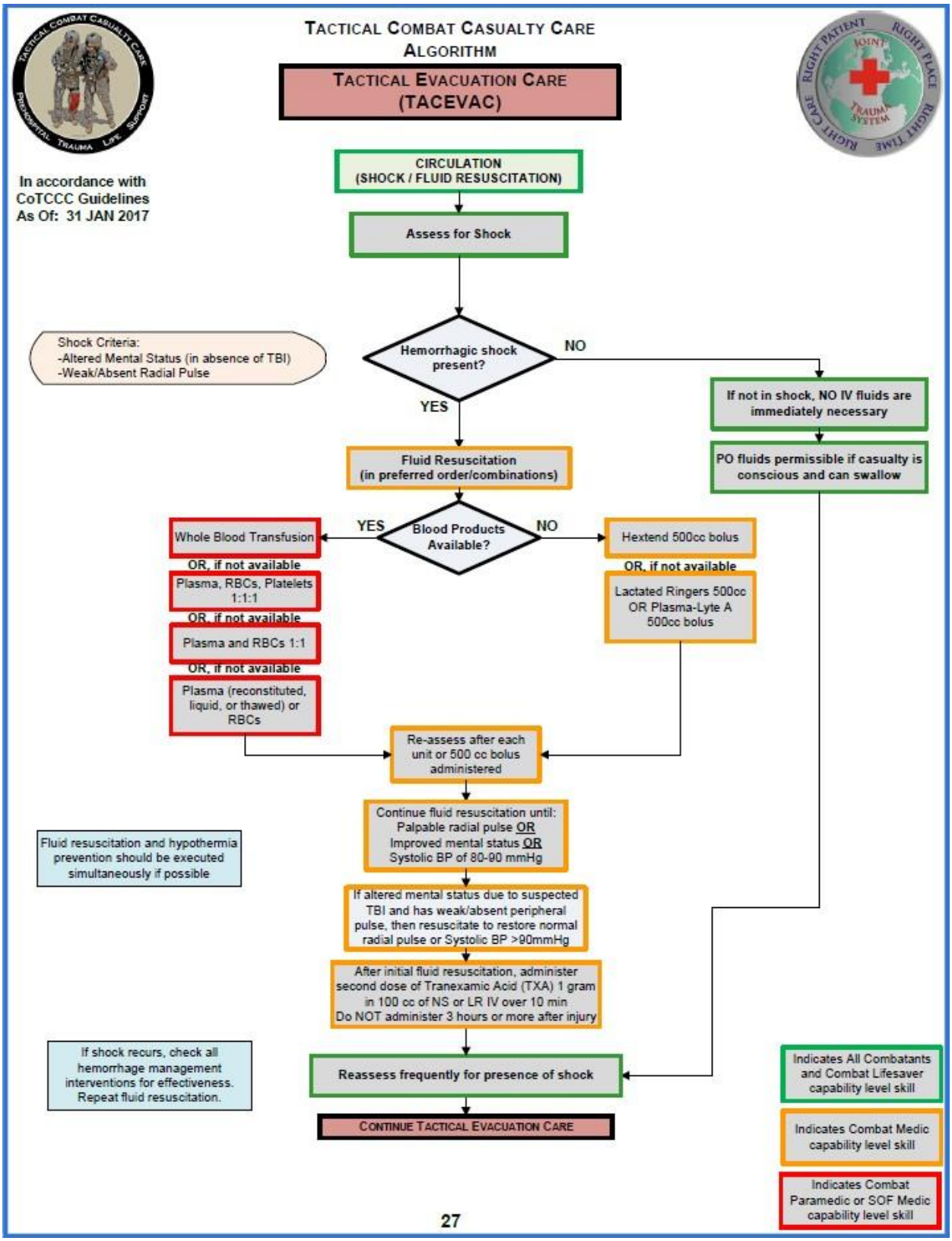
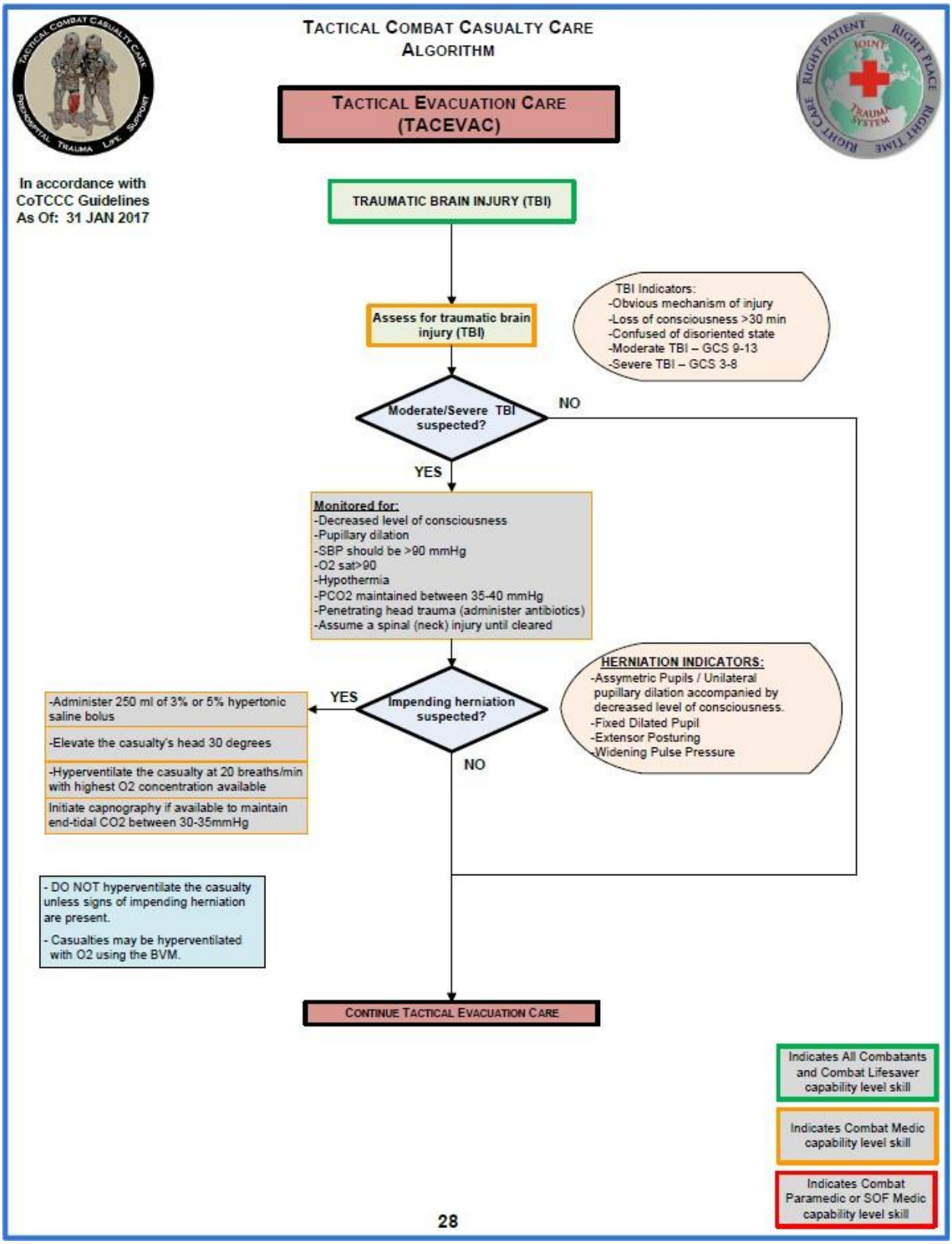

TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
CIRCULATION (SHOCK / FLUID RESUSCITATION)
Assess for Shock
Shock Criteria:
-Altered Mental Status (in absence of TBI)
-Weak/Absent Radial Pulse
Hemorrhagic shock present?
NO
YES
If not in shock, NO IV fluids are immediately necessary
PO fluids permissible if casualty is conscious and can swallow
Fluid Resuscitation (in preferred order/combinations)
Blood Products Available?
YES
NO
Whole Blood Transfusion
OR, if not available
Plasma, RBCs, Platelets 1:1:1
OR, if not available
Plasma and RBCs 1:1
OR, if not available
Plasma (reconstituted, liquid, or thawed) or RBCs
Hextend 500cc bolus
OR, if not available
Lactated Ringers 500cc OR Plasma-Lyte A 500cc bolus
Re-assess after each unit or 500 cc bolus administered
Continue fluid resuscitation until: Palpable radial pulse OR Improved mental status OR Systolic BP of 80-90 mmHg
Fluid resuscitation and hypothermia prevention should be executed simultaneously if possible
If altered mental status due to suspected TBI and has weak/absent peripheral pulse, then resuscitate to restore normal radial pulse or Systolic BP >90mmHg
After initial fluid resuscitation, administer second dose of Tranexamic Acid (TXA) 1 gram in 100 cc of NS or LR IV over 10 min Do NOT administer 3 hours or more after injury
If shock recurs, check all hemorrhage management interventions for effectiveness. Repeat fluid resuscitation.
Reassess frequently for presence of shock
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
27


TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
TRAUMATIC BRAIN INJURY (TBI)
Assess for traumatic brain injury (TBI)
TBI Indicators:
-Obvious mechanism of injury
-Loss of consciousness >30 min
-Confused of disoriented state
-Moderate TBI – GCS 9-13
-Severe TBI – GCS 3-8
Moderate/Severe TBI suspected?
NO
YES
Monitored for:
-Decreased level of consciousness
-Pupillary dilation
-SBP should be >90 mmHg
-O2 sat>90
-Hypothermia
-PCO2 maintained between 35-40 mmHg
-Penetrating head trauma (administer antibiotics)
-Assume a spinal (neck) injury until cleared
Impending herniation suspected?
YES
NO
HERNIATION INDICATORS:
-Assymetric Pupils / Unilateral pupillary dilation accompanied by decreased level of consciousness.
-Fixed Dilated Pupil
-Extensor Posturing
-Widening Pulse Pressure
-Administer 250 ml of 3% or 5% hypertonic saline bolus
-Elevate the casualty's head 30 degrees
-Hyperventilate the casualty at 20 breaths/min with highest O2 concentration available
Initiate capnography if available to maintain end-tidal CO2 between 30-35mmHg
- DO NOT hyperventilate the casualty unless signs of impending herniation are present.
- Casualties may be hyperventilated with O2 using the BVM.
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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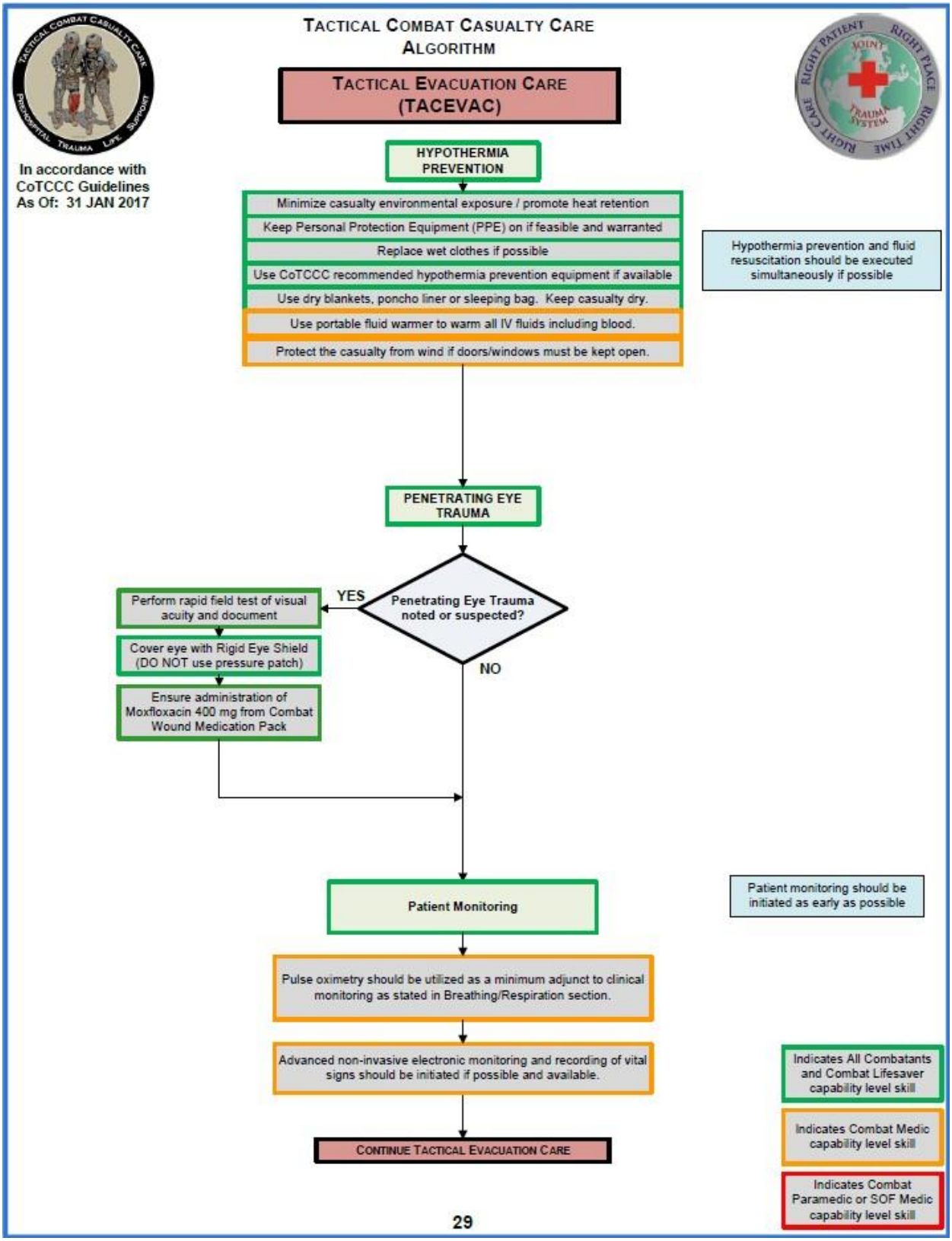
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
HYPOTHERMIA PREVENTION
Minimize casualty environmental exposure / promote heat retention
Keep Personal Protection Equipment (PPE) on if feasible and warranted
Replace wet clothes if possible
Use CoTCCC recommended hypothermia prevention equipment if available
Use dry blankets, poncho liner or sleeping bag. Keep casualty dry.
Use portable fluid warmer to warm all IV fluids including blood.
Protect the casualty from wind if doors/windows must be kept open.
Hypothermia prevention and fluid resuscitation should be executed simultaneously if possible
PENETRATING EYE TRAUMA
Penetrating Eye Trauma noted or suspected?
YES
Perform rapid field test of visual acuity and document
Cover eye with Rigid Eye Shield (DO NOT use pressure patch)
Ensure administration of Moxfloxacin 400 mg from Combat Wound Medication Pack
NO
Patient Monitoring
Patient monitoring should be initiated as early as possible
Pulse oximetry should be utilized as a minimum adjunct to clinical monitoring as stated in Breathing/Respiration section.
Advanced non-invasive electronic monitoring and recording of vital signs should be initiated if possible and available.
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
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Indicates Combat Paramedic or SOF Medic capability level skill
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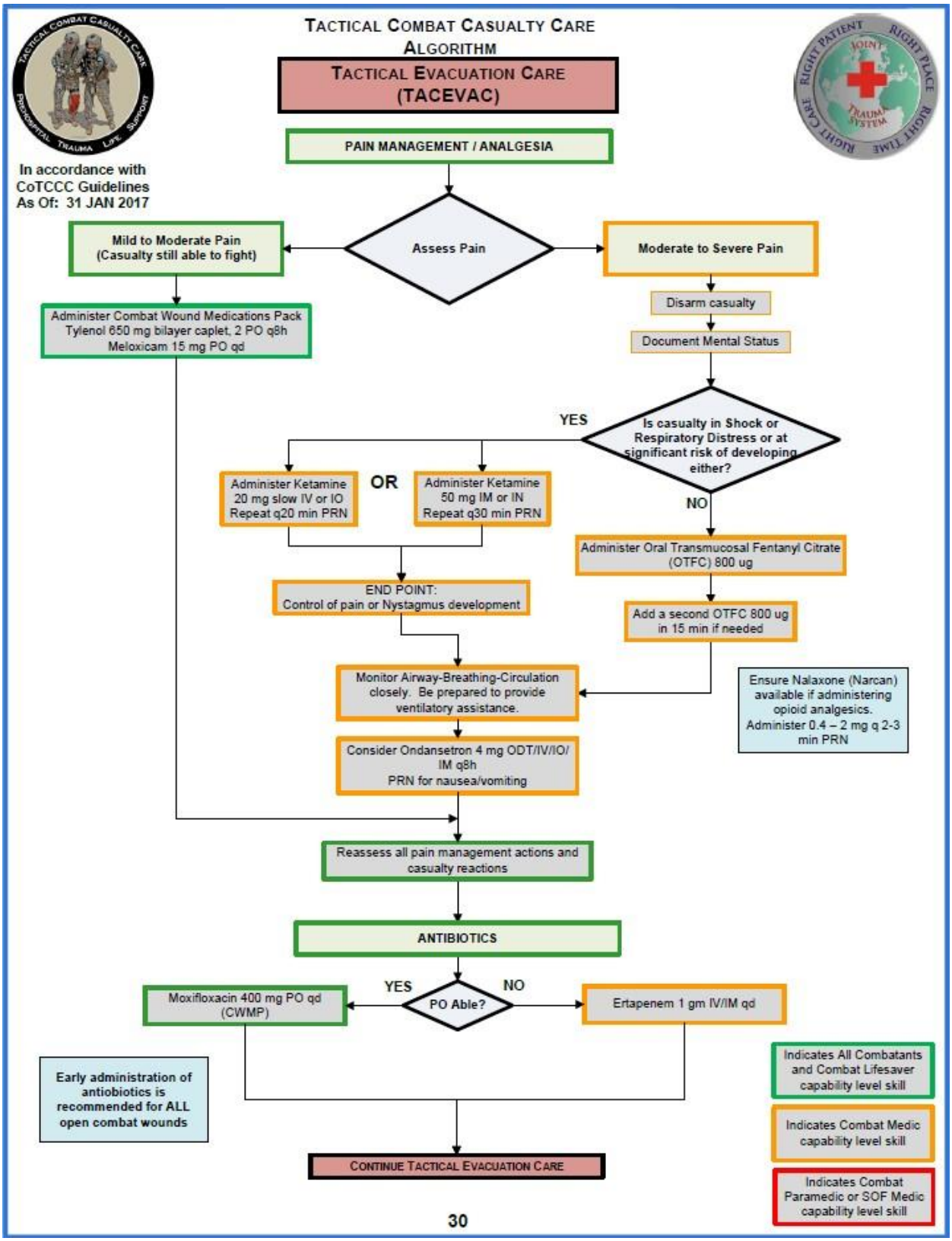
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
PAIN MANAGEMENT / ANALGESIA
Assess Pain
Mild to Moderate Pain (Casualty still able to fight)
Moderate to Severe Pain
Administer Combat Wound Medications Pack Tylenol 650 mg bilayer caplet, 2 PO q8h Meloxicam 15 mg PO qd
Disarm casualty
Document Mental Status
YES
Is casualty in Shock or Respiratory Distress or at significant risk of developing either?
NO
Administer Ketamine 20 mg slow IV or IO Repeat q20 min PRN
OR
Administer Ketamine 50 mg IM or IN Repeat q30 min PRN
Administer Oral Transmucosal Fentanyl Citrate (OTFC) 800 ug
END POINT: Control of pain or Nystagmus development
Add a second OTFC 800 ug in 15 min if needed
Monitor Airway-Breathing-Circulation closely. Be prepared to provide ventilatory assistance.
Ensure Nalaxone (Narcan) available if administering opioid analgesics. Administer 0.4 – 2 mg q 2-3 min PRN
Consider Ondansetron 4 mg ODT/IV/IO/ IM q8h PRN for nausea/vomiting
Reassess all pain management actions and casualty reactions
ANTIBIOTICS
YES
PO Able?
NO
Moxifloxacin 400 mg PO qd (CWMP)
Ertapenem 1 gm IV/IM qd
Early administration of antiobiotics is recommended for ALL open combat wounds
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
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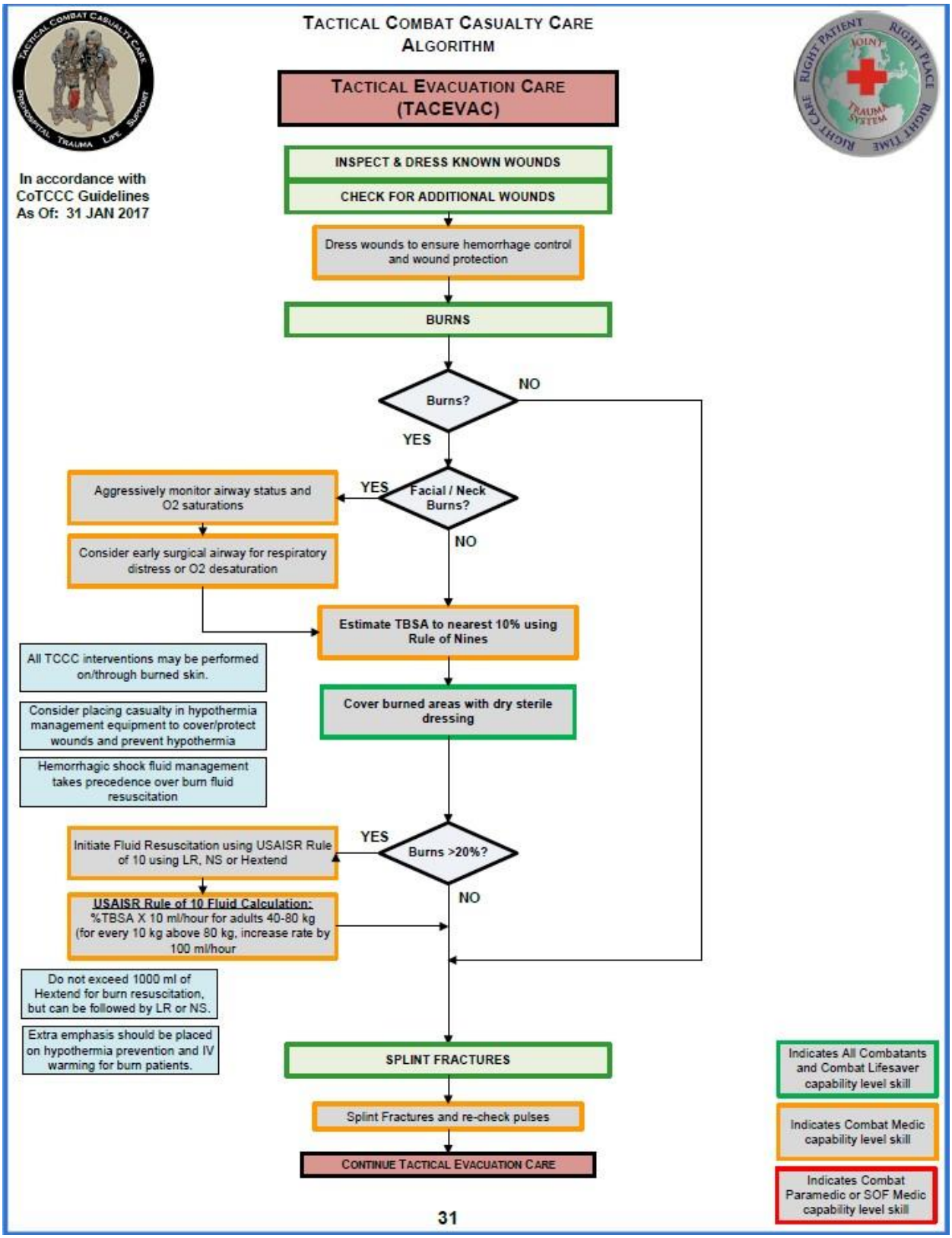
TACTICAL COMBAT CASUALTY CARE ALGORITHM
TACTICAL EVACUATION CARE (TACEVAC)
In accordance with CoTCCC Guidelines As Of: 31 JAN 2017
INSPECT & DRESS KNOWN WOUNDS
CHECK FOR ADDITIONAL WOUNDS
Dress wounds to ensure hemorrhage control and wound protection
BURNS
Burns?
NO
YES
Facial / Neck Burns?
YES
Aggressively monitor airway status and O2 saturations
Consider early surgical airway for respiratory distress or O2 desaturation
NO
Estimate TBSA to nearest 10% using Rule of Nines
All TCCC interventions may be performed on/through burned skin.
Consider placing casualty in hypothermia management equipment to cover/protect wounds and prevent hypothermia
Hemorrhagic shock fluid management takes precedence over burn fluid resuscitation
Cover burned areas with dry sterile dressing
Burns >20%?
YES
Initiate Fluid Resuscitation using USAISR Rule of 10 using LR, NS or Hextend
NO
USAISR Rule of 10 Fluid Calculation:
%TBSA X 10 ml/hour for adults 40-80 kg
(for every 10 kg above 80 kg, increase rate by 100 ml/hour
Do not exceed 1000 ml of Hextend for burn resuscitation, but can be followed by LR or NS.
Extra emphasis should be placed on hypothermia prevention and IV warming for burn patients.
SPLINT FRACTURES
Splint Fractures and re-check pulses
CONTINUE TACTICAL EVACUATION CARE
Indicates All Combatants and Combat Lifesaver capability level skill
Indicates Combat Medic capability level skill
Indicates Combat Paramedic or SOF Medic capability level skill
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TACTICAL COMBAT CASUALTY CARE ALGORITHM

In accordance with CoTCCC Guidelines As Of: 31 JAN 2017

TACTICAL EVACUATION CARE (TACEVAC)

COMMUNICATION

Communicate with casualty and medical providers in evacuation chain

- **Communicate with Casualty**
  - Encourage, reassure, explain care if possible
- **Communicate with Receiving Medical Facility**
  - Communicate with medical providers on evac asset if possible.
  - Relay mechanism of injury, injuries sustained, signs/ symptoms, and treatments rendered.

Cardiopulmonary Resuscitation (CPR) Considerations

CPR may be attempted in TACEVAC if casualty does not have obviously fatal wounds and quickly arriving at a surgical capability. CPR should not be attempted if compromising the mission or denying lifesaving treatment to other casualties.

Casualties with torso or polytrauma with no pulse or respirations should have bilateral needle decompression performed to confirm/deny tension pneumothorax prior to discontinuing care.

DOCUMENTATION

Document clinical assessments, treatments rendered, and changes on DD1380 TCCC Card and forward with casualty to next level of care.

NEXT LEVEL CARE

Indicates All Combatants and Combat Lifesaver capability level skill

Indicates Combat Medic capability level skill

Indicates Combat Paramedic or SOF Medic capability level skill

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VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

5. Blood/Fresh Frozen Plasma(FFP) Administration and Protocol

INDICATIONS: If the patient is in shock, especially in the presence of known or suspected non-compressible hemorrhage, then resuscitate with 2 units of plasma followed by PRBCs in a 1:1 ratio. If blood components are not available AND you are trained and comfortable with the procedure, collect and transfuse fresh whole blood. Resuscitate and attempt to maintain a palpable radial pulse or clinical improvement. If BP monitoring is available, maintain target systolic BP of 80-90mmHg (at least 90mmHg in the presence of TBI).

OVERVIEW:

1. Whole blood (WB) is blood that has not been modified except for the addition of an anticoagulant. WB provides the equivalent of Fresh Frozen Plasma (FFP), RBCs and Platelets (PLTSs) in a 1:1:1 ratio. FWB will have a shelf-life of 24 hours and should be transfused immediately or stored at 33-43 degrees F (1-6 degrees C) within 8 hours after collection, unless otherwise directed by medical staff due to insufficient or no red blood cell (RBC) or plasma product inventory. It should be tested with rapid test kits to decrease the risk of infectious disease transmission. Identify a blood donor who is ABO identical with the intended recipient.
2. WB is sometimes referred to fresh whole blood (FWB) if it has been recently collected. However, there is no time standard as to when it is no longer considered to be fresh. It is also referred to as warm fresh whole blood (WFWB) when it is still warm following collection. WB is separated into different components.

*** Any separated component, including RBCs or Packed RBCs (PRBCs), is considered a blood component and therefore **CANNOT** be correctly referred to as blood. Blood refers to WFWB, FWB, and WB.

3. The following are in use depending on theater of operations:
   a. Fresh frozen plasma (FFP)
   b. Packed red blood cells (PRBCs)
   c. Warm fresh whole blood (WFWB)
   d. Fresh whole blood (FWB)
   e. Whole blood (WB)
4. Prior to initiation of transfusion, the following will be checked:
   a. Vital signs (T, P, R, BP). Measure, evaluate and record baseline vital signs. Every effort should be made to monitor temperature as **an increase in temperature may be the first indicator of a transfusion reaction**.
   b. Casualty blood type should be confirmed.
      i. In an emergency, establish ABO/Rh of recipients and donors via local testing or previous testing.
      ii. EldonCard® tests should ONLY be used to confirm previous results obtained using the ABO/Rh test tube method.

Identification tags for ABO/Rh verification should be utilized as a last resort only. Accurate identification and verification of the donor's blood and the intended recipient may be the single most important step in ensuring transfusion safety.

   c. Active warming loss prevention should be used to prevent casualty hypothermia.

Transfusions

1. Ideally blood products should be warmed to approximately 98.6 °F (37 °C) prior to transfusion. Do not exceed 102 °F (39 °C). This may cause an inflammatory reaction and lyse some of the red cells.

Do not use warmers directly against the fluid bag because of the risk of hemolysis or damage to the blood or blood product. Blood or blood components should not be warmed in a microwave, unless it is specifically designed for that purpose.

2. Blood/blood components may be infused using a pressure infuser that encases the entire blood collection bag. Do not use a BP cuff for infusion as they deliver uneven pressure. Do not exceed 300mmHg with the pressure infusion device.

3. The largest bore IV catheter should be used. An IO device may be used. Ensure that a strong flush is done and good flow is obtained prior to using an IO infusion.

4. When performing any administration of blood or blood components the patient should be continuously monitored for signs and symptoms of an immunologic blood transfusion reaction. The first 10-15 minutes of any transfusion are the most critical.
   a. **Anaphylactic Reaction**
      i. Shock
      ii. Hypotension
      iii. Angioedema (red, swollen face)
      iv. Respiratory distress
   b. **Acute Hemolytic Transfusion Reaction**
      i. Acute Hemolytic Reaction usually has onset within 1 hour
      ii. Evidence of disseminated intravascular coagulopathy (DIC) – oozing from blood draw, IV sites.
      iii. Flushing, especially in the face
      iv. Fever and increase in core temp of more than 2 degrees F (1 degree C)
      v. Shaking, chills (rigor)
      vi. Flank pain or the acute onset of pain in the chest (retrosternal), abdomen and thighs
      vii. Wheezing, dyspnea
      viii. Anxiety, feeling of impending doom
      ix. Nausea and vomiting
      x. Hypotension
      xi. Pain, inflammation, and/or warmth at the infusion site
      xii. Red or Brown Urine (hemoglobinuria)-The onset of red urine during or shortly after a blood transfusion may represent hematuria (indicating bleeding in the lower urinary tract (tube #1 below) or hemoglobinuria (indicating an acute hemolytic reaction, tube #2 below). If freshly collected urine from a patient with hematuria is centrifuged, red blood cells settle at the bottom of the tube, leaving clear yellow urine supernatant (see tube #3 below). If the red color is due to hemoglobinuria, the urine sample remains red after centrifugation (see tube #4 below).

c. **Febrile Non Hemolytic Reactions**
   i. Fever not as severe as with an acute hemolytic reaction
   ii. Chills
   iii. Dyspnea
d. **Urticarial Reactions** - Urticaria
e. **Other transfusion related signs and symptoms**
   i. Flushing (especially in the face), urticaria, or edema
   ii. Increased pulse or respiratory rate
   iii. Nausea, vomiting or diarrhea
   iv. Pain and/or edema at the infusion site
   v. Headache
   vi. Feeling of impending doom
f. **Citrate Toxicity**
   i. Mild
      (a) Perioral and periorbital paresthesia
      (b) Metallic taste in the mouth
      (c) "Tingling" sensation around the mouth or in the extremities
   ii. Severe
      (a) Carpopedal spasms
      (b) Twitching
      (c) Chills
      (d) Stomach cramps
      (e) Pressure in the chest
      (f) Hypotension and possible cardiac arrhythmia
      (g) Nausea and/or vomiting
      (h) Tetany
      (i) Laryngeal spasm
      (j) Seizures
      (k) Bradycardia
   iii. Treatment
      (a) **Mild Toxicity** - Slow or stop transfusion until symptoms subside. Ensure proper mixture and concentration of citrate
      (b) **Severe Toxicity** - 10ml of a 10% solution of Calcium Gluconate SLOW IV push.

Do not rapidly infuse Calcium nor give more than one dose without the ability to monitor electrolytes. This may lead to cardiac arrhythmias.

5. Treatment of Immunologic Blood Transfusions Reactions. The first step in treating ALL transfusion related issues is to **STOP** the transfusion and save all of the blood products and equipment used for administration and typing for follow-up testing.

a. **Anaphylactic Reactions**
   i. Epinephrine 0.5ml of 1:1000 IM
   ii. Airway maintenance and oxygenation
   iii. Resuscitate hypotensive patients with IV fluids
   iv. Diphenhydramine, Dexamethasone, Zantac
b. **Acute Hemolytic Transfusion Reaction (AHTR)**
   i. Immediately STOP the transfusion
   ii. Initial Treatment

(a) Secure and maintain airway
(b) Begin an IV infusion of crystalloid.
NOTE: DO NOT run any fluid through the line that was carrying blood.
(c) The goal of fluid resuscitation is to maintain a urine output of 100-200ml/hr until the urine is clear of hemolyzed RBCs.
(d) Administer mannitol 20% (Osmitrol®) 20gm IV over 5 minutes using a blood administration filter to prevent infusion of mannitol crystals. If diuresis does not occur, repeat the 20gm dose once. The patient should receive a Foley catheter to monitor urine output.
(e) If mannitol 20% (Osmitrol®) is unavailable or does not produce diuresis, administer furosemide (Lasix®) 40-80mg initially and titrate later doses to maintain urine output of 100-200cc/hr.
(f) However, if urine output is not obtained within 2-3 hours of administration of fluid, consider the development of Acute Renal Failure and discontinue further fluids.
(g) Consider using acetaminophen (Tylenol®, Ofirmev® [IV]) 1gm PO, PR, or IV (every 6 hours to treat discomfort associated with fevers. (Avoid the use of aspirin or other NSAIDS).
(h) Administer 25-50mg of diphenhydramine (Benadryl®) IM, or IV to treat associated histamine release from AHTR & help manage the chills/rigor.
NOTE: Antihistamine (IV administration) must never be mixed with blood or blood products in the same transfusion lines.

iii. **SAVE** remaining donor blood and any typing information available & evacuate w/ patient. This will allow for ABO/further diagnostic testing at the MTF.

c. Febrile Non Hemolytic Reactions

i. Treat with antipyretics. Acetaminophen (Tylenol®, Ofirmev® [IV]) 1gm PO, PR, or IV (avoid the use of aspirin and other NSAIDS).
ii. If symptoms abate and there is no evidence of an acute hemolytic reaction consider restarting the transfusion.
iii. Pretreatment with antipyretics and antihistamines is recommended in this protocol and commonly done although there is no evidence that is decreases the incidence of fever and urticaria associated with transfusions.

d. Urticarial Reactions

i. Treat with 25-50mg diphenhydramine (Benadryl ®) IM or PO.
ii. If symptoms abate and there is no evidence of an acute hemolytic reaction consider restarting the transfusion.

Administer Fresh Frozen Plasma (FFP)

1. Keep FFP frozen at -0.4 degrees F (-18 degrees C) or below.

2. Do not rough handle FFP before thawing because the bags can be easily cracked, broken, or damaged.

3. FFP should be thawed in a water bath with the FFP bag wrapped in a plastic overwrap bag to protect the ports from contamination and to lessen the risk of contaminating the water bath if the FFP bag is broken or cracked (See Enclosure #2: Suggested Packing List). Thaw FFP at 98.6 degrees F (37 degrees C) or by using a method and/or equipment that is intended (validated) for such use. Do not exceed 107 degrees F (42 degrees C).

4. Turn the plasma during the thawing process and ensure that all fibrin clots are dissolved.

5. The plasma should be administered as rapidly as possible after thawing. Keep plasma refrigerated at 33-43 degrees F (1-6 degrees C) prior to administration.

6. Thawed plasma can be stored for 3 days at 33-43 degrees F (1-6 degrees C) and then should be returned to the MTF for use. If thawed plasma cannot be returned to and MTF for use then it should be discarded after storage at 33-43 degrees F (1-6 degrees C) for 5 days. Thawed plasma can only be kept for 30 minutes at room temperature (68-75 degrees F [20-24 degrees C]).

7. **AB is the universal donor for plasma.**

8. FFP is normally supplied as type AB or A.

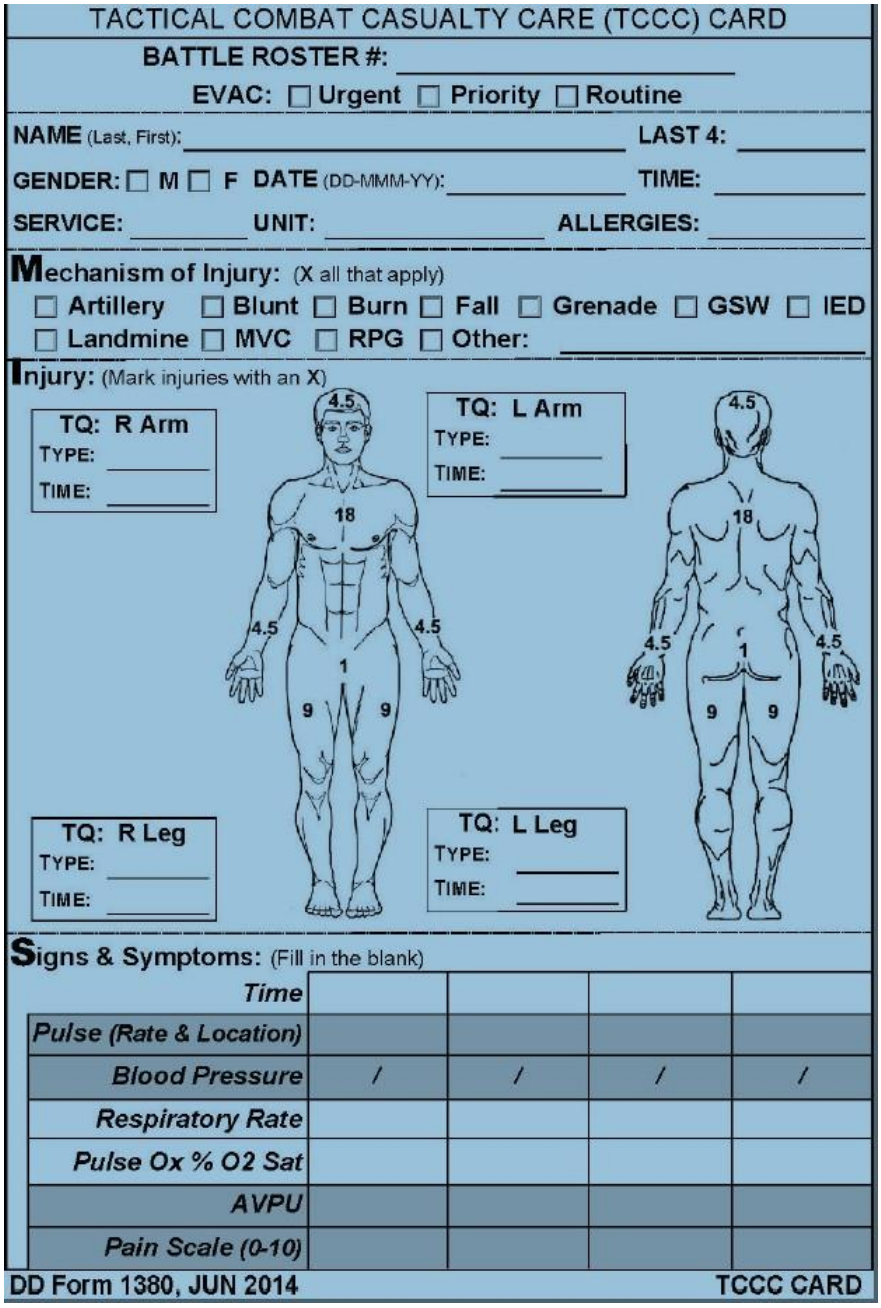
9. Rh factor is not a concern when administering FFP.

10. Ensure compatibility of recipient.

11. Administer 2 units of FFP and then begin administering PRBCs in a 1:1 ratio if available. You may bolus or pressure infuse FFP immediately.

VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

6. DD1380 TCCC Card



TACTICAL COMBAT CASUALTY CARE (TCCC) CARD

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

NAME (Last, First): _____ LAST 4: _____

GENDER: ☐ M ☐ F DATE (DD-MMM-YY): _____ TIME: _____

SERVICE: _____ UNIT: _____ ALLERGIES: _____

Mechanism of Injury: (X all that apply)

☐ Artillery ☐ Blunt ☐ Burn ☐ Fall ☐ Grenade ☐ GSW ☐ IED

☐ Landmine ☐ MVC ☐ RPG ☐ Other: _____

Injury: (Mark injuries with an X)

TQ: R Arm
TYPE: _____
TIME: _____

TQ: L Arm
TYPE: _____
TIME: _____

TQ: R Leg
TYPE: _____
TIME: _____

TQ: L Leg
TYPE: _____
TIME: _____

Signs & Symptoms: (Fill in the blank)

Time				
Pulse (Rate & Location)				
Blood Pressure	/	/	/	/
Respiratory Rate				
Pulse Ox % O2 Sat				
AVPU				
Pain Scale (0-10)				

DD Form 1380, JUN 2014 TCCC CARD

VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

7. DD1380 TCCC Card

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

Treatments: (X all that apply, and fill in the blank) — *Type*

C: TQ- ☐ Extremity ☐ Junctional ☐ Truncal _____

Dressing- ☐ Hemostatic ☐ Pressure ☐ Other _____

A: ☐ Intact ☐ NPA ☐ CRIC ☐ ET-Tube ☐ SGA _____

B: ☐ O2 ☐ Needle-D ☐ Chest-Tube ☐ Chest-Seal _____

C:

	Name	*Volume*	*Route*	*Time*
Fluid				
Blood Product				

MEDS:

	Name	*Dose*	*Route*	*Time*
Analgesic (e.g., Ketamine, Fentanyl, Morphine)				
Antibiotic (e.g., Moxifloxacin, Ertapenem)				
Other (e.g., TXA)				

OTHER: ☐ Combat-Pill-Pack ☐ Eye-Shield (☐ R ☐ L) ☐ Splint

☐ Hypothermia-Prevention Type: _____

NOTES:

FIRST RESPONDER

NAME (Last, First): _____ **LAST 4:** _____

DD Form 1380, JUN 2014 (Back) **TCCC CARD**

VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

8. Triage Categories

IMMEDIATE
This category includes those casualties who require an immediate LSI and/or surgery. Put simply, if medical attention is not provided they will die. **The key to successful triage is to locate these individuals as quickly as possible. Casualties do not remain in this category for an extended period of time. They are either found, triaged and treated, or they die!** Hemodynamically unstable casualties with airway obstruction, chest or abdominal injuries, massive external bleeding, or shock deserve this classification.
DELAYED
This category includes those wounded who are likely to need surgery, but whose general condition permits delay in surgical treatment without unduly endangering the life, limb, or eyesight of the casualty. Sustaining treatment will be required (e.g., oral or IV fluids, splinting, administration of antibiotics and pain control), but can possibly wait. Examples of casualties in this category include those with no evidence of shock who have; large soft tissue wounds, fractures of major bones, intra-abdominal and/or thoracic wounds, and burns to less than 20% of total body surface area (TBSA).
MINIMAL
Casualties in this category are often referred as the "walking wounded." Although these patients may appear to be in bad shape at first, it is their physiologic state that tells the true story. These casualties have minor injuries (e.g., small burns, lacerations, abrasions, or small fractures) that can usually be treated with self- or buddy-aid. These casualties should be utilized for mission requirements (e.g., scene security), to help treat and/or transport the more seriously wounded, or put back into the fight.
EXPECTANT
Casualties in this category have wounds that are so extensive, that even if they were the sole casualty and had the benefit of optimal medical resources, their survival would be highly unlikely. Even so, expectant casualties should not be neglected. They should receive comfort measures and pain medication if possible, and they deserve re-triage as appropriate. Examples of expectant casualties are the unresponsive with injuries such as penetrating head trauma with obvious massive damage to the brain.

EVACUATION PRECEDENCE

URGENT / CATEGORY A (WITHIN 2 HOURS) *	PRIORITY / CATEGORY B (WITHIN 4 HOURS)	ROUTINE / CATEGORY C (WITHIN 24 HOURS)
• Significant injuries from a dismounted IED attack • Gunshot wound or penetrating shrapnel to chest, abdomen, or pelvis • Any casualty with ongoing airway difficulty • Any casualty with ongoing respiratory difficulty • Unconscious casualty • Casualty with known or suspected spinal injury • Casualty in shock • Casualty with bleeding that is difficult to control • Moderate/Severe TBI • Burns greater than 20% Total Body Surface Area	• Isolated, open extremity fracture with bleeding controlled • Any casualty with a tourniquet in place • Penetrating or other serious eye injury • Significant soft-tissue injury without major bleeding • Extremity injury with absent distal pulses • Burns over 10-20% of Total Body Surface Area	• Concussion (mild traumatic brain injury) • Gunshot wound to extremity - bleeding controlled without tourniquet • Minor soft-tissue shrapnel injury • Closed fracture with intact distal pulses • Burns over < 10% Total Body Surface Area

* Note that by Secretary of Defense directive, all casualties categorized as CAT A in the Afghanistan theater of operations should be able to be evacuated to an MTF with a surgical capability within 60 minutes from the time that the evacuation mission is approved.

VI. TACTICAL COMBAT CASUALTY CARE (TCCC)

9. 9 – Line / MIST Report

MEDEVAC REQUEST 9-LINE		
LINE 1: LOCATION OF UNIT	HLZ GRID (MGRS):	
LINE 2: CALLSIGN AND FREQUENCY AT THE PZ	CALLSIGN: FREQUENCY:	
LINE 3: NUMBER AND PRECEDENCE OF CASUALTIES	A: Number of Urgent Casualties B: Number of Priority Casualties C: Number of Routine Casualties	
LINE 4: SPECIAL EQUIPMENT REQUIRED	A: None B: Hoist C: Extraction D: Ventilator E: Other (specify)	
LINE 5: NUMBER OF CASUALTIES BY TYPE	L: Number of Litter Casualties A: Number of Ambulatory Casualties E: Number of Escorts	
LINE 6: SECURITY AT PZ	N: No enemy P: Possible enemy E: Enemy in area X: Armed escort required	
LINE 7: PZ MARKING	A: Panels B: Pyrotechnics C: Smoke (designate color) D: None E: Other (specify)	
LINE 8: CASUALTIES BY NATIONALITY/STATUS	A: US/Coalition Military B: US/Coalition Civilian C: Non-Coalition D: Non-Coalition Civilian E: Opposing Forces/Detainee F: Child	
LINE 9: PZ TERRAIN/OBSTACLES (CBRN CONTAMINATION IF APPLICABLE)		Brief description of significant obstacles on approach / departure headings and type of predominant terrain for the HLZ

MIST REPORT	
M – MECHANISM OF INJURY AND TIME OF INJURY (IF KNOWN)	Mechanism of Injury and time of injury (if known)
I – INJURY OR ILLNESS	Injury or Illness
S – SYMPTOMS AND VITAL SIGNS	A – Airway status B – Breathing rate C – Pulse rate D – Conscious/Unconscious E – Other signs
T – TREATMENT GIVEN	Such as Tourniquet/Time Applied Drugs administered

VII. CANINE PROTOCOL(Military & DOD working Dogs)

K-9 Trauma Management Protocol

SIGNS AND SYMPTOMS for Shock:
1. Pale color in gums, capillary refill time greater than 2 seconds
2. Dry lips and gums, dehydration
3. Excessive drooling in some poisoning cases
4. Weak femoral pulse
5. Rapid heart rate of 150-200 beats per minute
6. Cool extremities
7. Hyperventilation, rapid breathing generally over 25 breaths per minute (panting may or may not be normal)
8. Confusion, restless, anxiousness
9. General weakness

Advanced stages of shock:
1. Continued depression and weakness to the point of not being able to move or becoming unresponsive or unconscious
2. Dilated pupils
3. Capillary refill time greater than 4 seconds
4. White mucous membranes
5. Rectal temperature below 98° F.

MANAGEMENT:

1. **MARCHE** Protocol
2. **Muzzle, M**assive hemorrhage: Control bleeding per TCCC standards, Morphine
   A. Muzzle
   B. Massive hemorrhage: Control bleeding with direct pressure and pressure dressings. Tourniquets are not as effective in dogs due to anatomical differences. All hemostatic agents used in humans are safe for use in dogs.
   C. Morphine: 10-30mg IM. May cause vomiting and respiratory depression. Use Naloxone (0.02mg/kg) for reversal if necessary.
3. **A**irway
   A. An injured dog or an animal in shock may not recognize you. The dog may bite you out of pain or fear. If the dog is having trouble breathing or panting heavily, **DO NOT** apply a muzzle. If a

muzzle is placed on the dog it must be monitored at all times and removed at the first sign of overheating or vomiting because they can easily aspirate. Get help if possible from someone who can help hold the dog, so you can do an examination and/or treat the dog.

1) Carefully pull the tongue out of the animal's mouth.
2) Even an unresponsive dog may bite by instinct!!
3) Make sure that the neck is reasonably straight; try to bring the head in-line with the neck.
4) Do not hyperextend in cases where neck trauma exists

B. Intubation or tracheostomy if necessary to assure airway

1) Do not attempt to intubate a conscious animal, personnel must have prior training. ET tube size can range from 7-10.

C. If intubation is not possible, then attempt tracheostomy.

D. After achieving a patent airway, one must determine whether the animal is breathing, and whether this breathing is effective.

E. **AIRWAY CONSIDERATIONS:**

1) Size 7mm to 10mm cuffed endotracheal tube, secure with gauze or IV tubing. Tie over nose.
2) Flow by oxygen – secure airline to muzzle.
3) Field expedient O_2 masks.
4) Nasal trumpets are ineffective in canines

4. **R**espirations

A. Look, Listen, and Feel

B. If not breathing, ventilate the animal by closing the mouth, and performing mouth-to-nose ventilations. If patient is intubated or has tracheostomy, ventilate the animal using an Ambu-bag.

C. Ventilate at 20 breaths per minute.

D. If available, use supplemental oxygen

E. Needle thoracentesis: Place the dog in the lateral recumbency, go midway between sternum and spine between the 7th and 9th ribs. Use a 14G 3.25in needle. Perform needle decompression on both sides.

5. **C**irculation

A. Be sure that there are no major (pooling/spurting blood) points of bleeding. Control as necessary.

B. Hemorrhagic Shock Fluid Resuscitation (Administration Routes):

1) Primary route is IV
2) Secondary route is IO (Tibia or Humerus) on a sedate or unconscious dog only.

C. Incorporate crystalloids and colloids as needed

1) Bolus of crystalloid, 10-20ml/kg, reassess and repeat a maximum of 2 times
2) Bolus of colloid, 5-10ml/kg given once over 20-30 minutes.

D. The targeted endpoint for resuscitation should be to achieve and maintain permissive hypotension.

E. Blood transfusion (dog-to-dog), if available.

1) For the first transfusion in a trauma/field situation it is generally safe to give any type of blood without typing or cross-matching.
2) Collect no more than 20% blood volume (collect 1 unit/450ml from typical size working dog). Perform a sterile prep and use the jugular vein for collection.
3) In a trauma/field situation you will usually administer the whole unit. Human blood transfusion guidelines apply for rate and monitoring requirements.

6. **H**ypothermia: Prevent loss of body heat. Dry the fur. Use a hypothermia blanket. Watch for overheating.

7. Evacuation and Everything Else

A. TXA – Administer 10-15ml/kg IM or slowly IV

B. Analgesia

1) Morphine: Administer 0.5-1mg/kg IM or IV, may cause vomiting

2) Hydromorphone/Dilaudid: Administer 0.1-0.2mg/kg IM or IV, may cause vomiting
3) Fentanyl: Administer 3-4mcg/kg IV; Can also use a fentanyl lollipop inserted in the rectum secured with tape to the tail base
4) Naloxone: Opiod reversal , administer at 0.02-0.04mg/kg IV, IM, or SQ

C. Antibiotic Therapy for Penetrating Wounds
1) Ceftriaxone (Rocephin) 1gm IV / IM daily
2) **E**rtapenem (Invanz) 500mg IV / IM two times a day

Monitoring:

K-9 EVALUATION AND TREATMENT PROTOCOL

VITAL SIGNS OF CANINES:

Parameter	Value	Parameter	Value
Pulse	60-120 bpm	HCT/PCV	37-55%
Respiration	8-24 bpm	SPO2	95-100%
Temp	100-102.5 F	ET CO2	35-45 mm Hg
CRT	<2 sec	Total Protein	5-7.5g/dl

1. Temperature:
   A. Normal Rectal Temp is 100-102.5° F.
   B. Temperature after exercise: 103-106° F. Temperature should return to normal within 15 minutes after completion.
2. Pulse
   A. Normal pulse rate will vary from 60-120bpm. Can beat up to 150 with exercise.
   B. The pulse rate and respiratory rate will vary from dog to dog, and will also vary if the dog is at rest or working.
   C. The femoral artery is located on the inside of a dog's rear thighs. Take your hand as if you were passing someone a plate, grab the dog on the front of their thigh with your fingers inside the thigh, and palpate the artery.
3. Normal respiratory rate for an adult dog will vary between 8-24 respirations per minute
4. Capillary refill time: less than 2 seconds.
5. Mucous membrane color: generally pink.

SPECIFIC WEIGHT RELATED DRUG DOSES ARE AT THE END OF THIS PROTOCOL. MOST DOG HANDLERS WILL CARRY A DRUG CARD FOR THE DOG.

MONITORING:

1. Pulse Ox – Placed on tongue, ear, or other non-pigmented highly vascular area such as the lip, vulva, or prepuce.
2. EKG – Alligator clips behind each elbow and above left knee. If you do not have alligator clips place the buttons or leads behind the largest pad on the foot. Sticky pads can also be placed on the largest pad on the foot of the left and right forelimbs and the left hindlimb.
3. Animals do not have palpable carotid pulses. You can obtain a femoral pulse in the inguinal crease.
4. End Tidal CO2 – Measure the same way you do in human patients. Normal value 35-45mm Hg.

Femoral Pulse Location:

IV/IM Sites

IM and SQ INJECTION SITES:

IM Injections

1. Gluteal Site: palpate muscle belly between fingers. Insert needle into muscle; pull back on plunger to ensure no blood is present. Inject if no blood and reposition needle if blood is present.

2. Epaxial Site: Place hand on back with middle finger located on spine and thumb just in front of the pelvis. Muscle belly will be where your index finger naturally falls.

Subcutaneous Injections

1. Lift skin between the shoulder blades, insert needle at 45 degree angle.

IV SITES:

Usually the easiest/best vein to use for a K-9 IV is the one found on their forelegs. The cephalic vein is located on the middle of the foreleg. This is the most commonly used vein for fluid administration and IV delivery of drugs.

If the person occluding the vein for you rolls it laterally, this will place the vein directly on top of the dog's leg, easing access.

Maintain a firm hold on the dogs leg as you place the catheter, as they will pull away from you while placing the catheter.

Start distally on the vein. If you blow the vein, move more proximally and attempt the IV.

An 18 gauge 1 ½" catheter can be used in both the cephalic and the saphenous veins.

In the hind leg, the lateral saphenous vein is used. This vein is harder to maintain and secure.

In both procedures use plenty of tape to secure the IV line. Your patient will try to pull it out. If they are ambulatory, movement will often dislodge the IV. IVs in conscious dogs must be monitored.

Cephalic Vein

Saphenous Vein

Hydration Status

HYDRATION STATUS:

1. Normal Hydration: Pick up skin and release. It should return to the original position within 1 second.
   A. Capillary Refill Time (CRT) is measured by pressing on the gums over the canine tooth. Using one finger, press down firmly until the gums turn white under your finger and release. Anything over two seconds is considered too long. Also, note the normal color of your dog's gums and mouth. Dog's gum color may vary from black, pink, brown or any combination of those colors.
2. Dehydration:
   A. 6-8% dehydration – loss of skin elasticity, tacky gums, mildly prolonged CRT
   B. 10-12% dehydration – tented skin, dry gums, prolonged CRT, sunken eyes, increased HR, rapid/weak pulses. Consider a 10-12% dehydration an emergency.
3. Dehydration Fluid Replacement
   A. Estimate dehydration
      1) 5% give 1000ml bolus IV
      2) 10% give 1500ml bolus IV
   B. Fluid choice is normal saline or Lactated Ringer's Solution. Oral fluid consumption is the best way to rehydrate a dog.

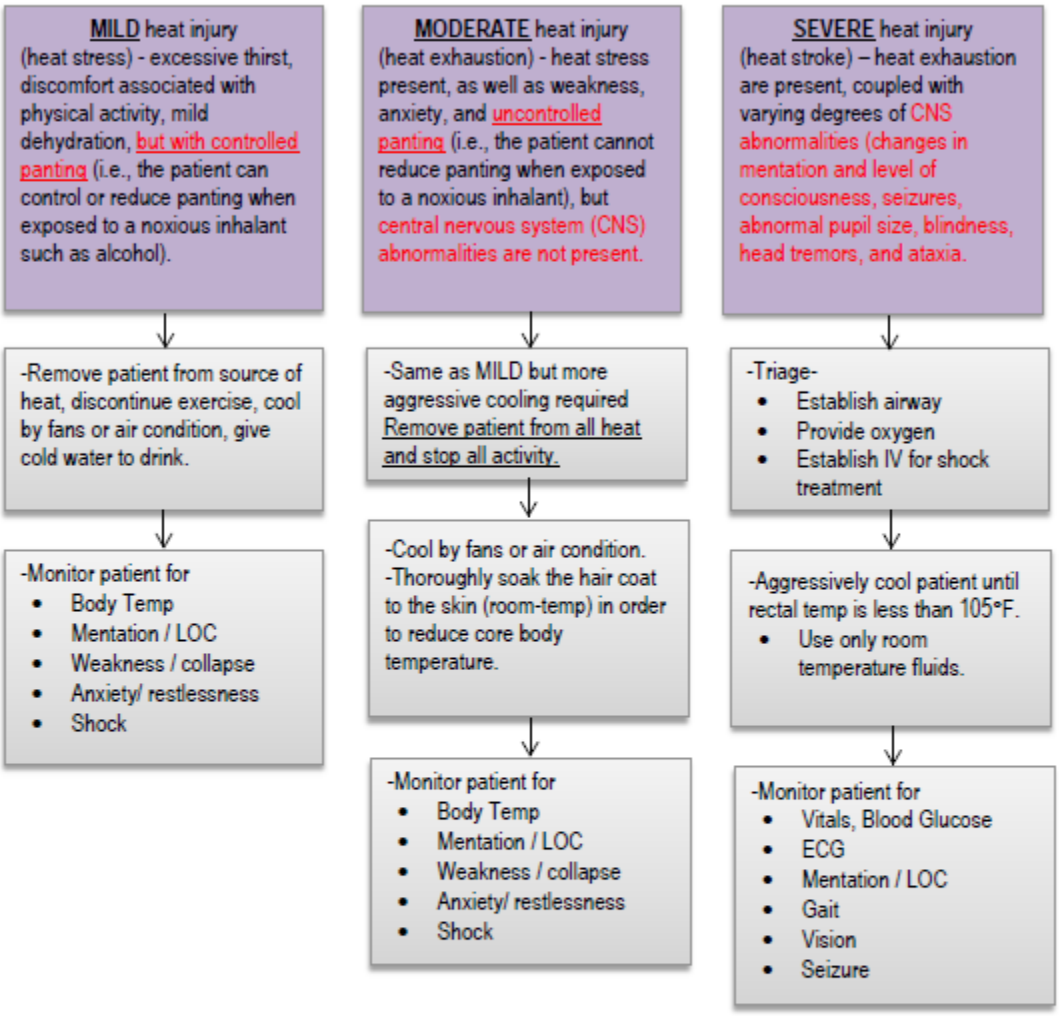
RESTRAINT (SOF medical personnel should work with handler to learn muzzling techniques):

1. Always muzzle dog when working on them.
2. Physical restraints with muzzles or improvised muzzles
   A. Field expedient muzzle:
      1) Kerlix is wrapped around the snout several times and then tied behind the head.

      2) The leash is wrapped around the snout and held tightly.

3. Chemical restraint if needed to protect handler and medic
   A. Dexdomitor (if not traumatic injury) reversed with Antisedan. Dexdomitor after onset gives 20-30 minutes of good sedation when administered with labeled dose.
   B. For mild sedation, a combination of Midazolam (0.3mg/kg) plus Ketamine (5mg/kg) can be administered IM or IV.
   C. For deep sedation, a combination of Morphine (1mg/kg) plus Midazolam (0.3mg/kg) plus Ketamine (5mg/kg) can be administered IM.
      1) Dilaudid/Hydromorphone (0.1mg/kg) may be used in place of Morphine.

MWD Heat Injury Treatment


MILD heat injury
(heat stress) - excessive thirst, discomfort associated with physical activity, mild dehydration, but with controlled panting (i.e., the patient can control or reduce panting when exposed to a noxious inhalant such as alcohol).
-Remove patient from source of heat, discontinue exercise, cool by fans or air condition, give cold water to drink.
-Monitor patient for
Body Temp
Mentation / LOC
Weakness / collapse
Anxiety/ restlessness
Shock
MODERATE heat injury
(heat exhaustion) - heat stress present, as well as weakness, anxiety, and uncontrolled panting (i.e., the patient cannot reduce panting when exposed to a noxious inhalant), but central nervous system (CNS) abnormalities are not present.
-Same as MILD but more aggressive cooling required Remove patient from all heat and stop all activity.
-Cool by fans or air condition.
-Thoroughly soak the hair coat to the skin (room-temp) in order to reduce core body temperature.
-Monitor patient for
Body Temp
Mentation / LOC
Weakness / collapse
Anxiety/ restlessness
Shock
SEVERE heat injury
(heat stroke) – heat exhaustion are present, coupled with varying degrees of CNS abnormalities (changes in mentation and level of consciousness, seizures, abnormal pupil size, blindness, head tremors, and ataxia.
-Triage-
Establish airway
Provide oxygen
Establish IV for shock treatment
-Aggressively cool patient until rectal temp is less than 105°F.
Use only room temperature fluids.
-Monitor patient for
Vitals, Blood Glucose
ECG
Mentation / LOC
Gait
Vision
Seizure

Clinical Pearls:

- **PANTING** is the only significant cooling mechanism for dogs.
- **NO** specific body temperature defines heat stroke in MWD's. Normal rectal temperature is 99.0° to 102.5° F in the MWD. Temperatures as low as 105.8°F have been associated with pathology. Most commonly, heat stroke is seen in MWDs with rectal temperatures greater than 107°F.
- **DO NOT** use of cold intravenous fluids, ice packs, or ice-water baths for cooling.
- Once the MWD's body temperature is <103° **CEASE** all cooling efforts and monitor for rebound hypothermia.

MWD CPR Management

Cardiopulmonary Arrest Confirmed

BEGIN BASIC LIFE SUPPORT- SUSTAIN CPR for 2-3 minute cycles

- **Circulation**- Chest compressions, FAST and HARD, 100 compressions per minute
- **Airway**- Clear airway and intubate; perform tracheostomy if obstructed airway
- **Breathing**- Manually ventilate with 100% O_2 at 8-10 breaths per minute

BEGIN ADVANCED LIFE SUPPORT
ECG (determine arrest rhythm)
IV / IO access for drug delivery

VF or VT

- Defibrillate- **2-5 J/kg**
- Resume chest compressions x 1 cycle
- Defibrillate twice more, with 1 compression cycle between each counter-shock, if refractory
- Drug therapy if counter-shock no successful:
  - Epinephrine **0.01 mg/kg** IV/IO
    or
    Vasopressin **0.8 U/kg** IV/IO **once**
    and
  - Lidocaine **2 mg/kg** IV/IO
    or
  - Amiodarone **5-10 mg/kg** IV/IO
- Repeat counter-shock (2 x initial energy) if refractory

ASYSTOLE/ BRADYCARDIA/ PEA

- Drug therapy:
  - Atropine **0.04 mg/kg** IV/IO
    and
  - Epinephrine **0.01 mg/kg** IV/IO
    or
  - Vasopressin **0.8 U/kg IV/IO once**

CPR EMERGENCY DRUG CACLUATION (Quick Reference)

Caution: you must first validate the drug concentrations on the bottle is the same as on this quick reference chart.

					Weight (Pounds)	50	60	70	80	90	100
					Weight (Kg)	22.7	27.3	32	36.3	41	45.5
DRUG/ACTION	[CONC]		DOSE		ROUTE	ml	ml	ml	ml	ml	ml
Vasopressin	20	units/ml	0.80	U/kg	IV / IO	0.91	1.09	1.28	1.45	1.64	1.82
Epinephrine (1:1,000)	1	mg/ml	0.01	mg/kg	IV / IO	0.23	0.27	0.32	0.36	0.41	0.46
Epinephrine (1:10,000)	0.1	mg/ml	0.01	mg/kg	IV / IO	2.27	2.73	3.20	3.63	4.10	4.55
Atropine	0.4	mg/ml	0.04	mg/kg	IV / IO	2.27	2.73	3.20	3.63	4.10	4.55
Lidocane (1%)	10	mg/ml	2.00	mg/kg	IV / IO	4.54	5.46	6.40	7.26	8.20	0.91
Amiodarone	50	mg/ml	5.00	mg/kg	IV / IO	2.27	2.73	3.20	3.63	4.10	4.55
Magnesium Sulfate (0.5 g/ml)	500	mg/ml	30.00	mg/kg	IV	1.36	1.64	1.92	2.18	2.46	2.73
Sodium Bicarbonate (8.4%)	1	mEq/ml	1.00	mEq/kg	IV	22.70	27.30	32.00	3.63	41.00	45.50
Defibrillate	2-5	J/kg	2.00	J/kg	External	45.40	54.60	64.00	72.60	82.00	91.00

Drug	Dose	Dose per 25kg K9
K9 - ALS DRUGS		
Epinephrine	0.01 mg/kg (1:1000) IV/IO, IM, IT q 3-5 min	0.25 mg
Atropine	0.04 mg/kg IV/IO, IM, IT q 3-5 min	1 mg
Lidocaine	2 mg/kg IV/IO, IT (slow IV/IO push over 1-2 min)	50 mg
NAVEL (naloxone, atropine, vasopressin, epinephrine, lidocaine) may be given via ETT (Intratracheal or IT) For IT administration increase IV dose 2–3× and dilute with 0.9 % saline or sterile water		
K9 - ANESTHETICS / CHEMICAL RESTRAINT		
Ketamine	2 - 4 mg/kg IV or 5 – 8 mg/kg IM *(with benzodiazepine)*	50 - 100 mg IV / IO 125 – 400 mg IM
Etomidate	1 mg/kg *(Administer a benzodiazepine prior to Etomidate)*	25 mg
Diazepam*(Valium®)	0.2 - 0.4 mg/kg IV/IO/IM or per rectum	5 - 10 mg
Midazolam* (Versed®)	0.2 - 0.5 mg/kg IV/IO/IM	5 - 10 mg
Lorazepam* (Ativan®)	0.2 mg/kg IV/IO/IM or intranasal once	5 mg
**(NOTE: Do not use Benzodiazepines alone for restraint, may cause paradoxical excitement)*		
K9 - OPIOIDS / ANALGESICS		
Fentanyl	Bolus or Loading Dose: 2-5 mcg/kg IV/IO/IM q 30 min Infusion: 3 – 6 mcg/kg/h	50 - 125 mcg 75 - 150 mcg/h
Hydromorpone (Dilaudid)	Bolus or Loading Dose: 0.1 mg/kg IV/IO/ IM q 2 - 4 h Infusion: 0.01 – 0.05 mg/kg/h	2.5 mg 0.25 - 1.25 mg/h
Morphine	Bolus or Loading Dose: 0.2–0.5 mg/kg IV/IO/IM q 1-4h ***Administer IV/IO Slowly over 3 - 5 min***	5 - 10 mg
	Infusion: 0.1 – 0.3mg/kg/h *(2.5 - 7.5 mg / h)*	2.5- 7.5 mg/h
*NOTE: **a)** Oral opiates tend not to be effective in K9's; **b)** Always start low and titrate to effect; **c)** monitor for respiratory depression and hypotension; **d)** have naloxone on hand for opiate reversal if needed; **e)** consider administering an antiemetic prior to the opiate		
DRUG REVERSALS		
Flumazenil (Romazicon®)	0.02mg/kg IV/IO; repeat every 30 - 60 min as needed	0.5 mg
Nalaxone (Narcan®)	0.04 -0.1 mg/kg IV/IO/IM/IT; repeat as necessary	1.0 - 2.5 mg

Drug	Dose	Dose per 25kg K9
GASTROPROTECTANTS (Antacids)		
Famotidine (Pepcid®)	0. 5 - 1.0 mg/kg IV or PO, q 12 h	10 -25 mg
Ranitidine (Zantac®)	2mg/kg IM or slow IV/IO q8-12h	50 mg
ANTI-EMETICS (Antinausea)		
Ondansetron (Zofran®)	0.2 - 0.5 mg/kg PO or IV (slowly IV over 2-15 minutes) q 8 h	5 - 10 mg
Promethazine (Phenergan®)	0.2 – 0.5 mg/kg PO q 6-8 h **low oral bioavailability in K9s*	5 - 10 mg
MISCELLANEOUS		
Albuterol	*Oral:* 0.02 – 0.05 mg/kg PO q8-12h	0.5 - 1.25 mg
	Inhaler: 2-4 puffs q 20 min until resolution of clinical signs	**Requires spacing chamber /mask*
Cetirizine	1 mg/kg PO q12-24 h	10 – 20 mg
EPI-PEN®	0.15 (pediatric) or 0.3 mg (adult) unit dose	0.15 - 0.3 mg IM
Dextrose 50% (glucose)	1 ml/kg (0.5 gm/kg) IV slowly *(dilute 1:2 with saline to make 25% solution)*	25 mL (25 gm)
Diphenhydramine (Benadryl®)	2 - 4 mg/kg q 8 - 12 hour IM or PO	50 - 100 mg
Lidocaine 1% without Epi	1 mg/kg injected for local anesthesia	25 mg (2.5 mL)
Mannitol 25% (250 mg/mL)	0.5 - 1.4 g/kg IV/IO over 20 - 30 min	12.5 - 35 g
Sodium Bicarbonate	1 mEq/kg, once, diluted IV, (for CPA > 10 min + pH< 7)	25 mEq
Tetracaine 0.5% (*Proparacaine*)	1 -2 gtts / eye	1 -2 gtts / eye
Tranexamic Acid	10 mg/kg IV, slow infusion	25 mg
*AVOID **NON-STEROIDAL ANTI-INFLAMMATORY** medications (e.g. aspirin, ibuprofen, naproxen, ketorolac, etc.) in the trauma patients		
ANTIBIOTICS		
Ampicillin +/- sulbactrum	20 – 40 mg/kg IV /IM q6-8h	500 – 1000mg
Cephalexin (Rilexine®)	22 – 30 mg/kg **PO** q 12h (ORAL)	500 – 1000 mg
Cefazolin (Ancef)	20 – 22 mg/kg IV or IM (large muscle)	500 – 1000 mg
Cefotetan (Cefotan)	30 mg/kg IV or SC q8h (Do not give IM – painful)	750 – 1000 mg
Ceftriaxone (Rocephin®)	25 - 50 mg/kg **IV** q24 h or 50 mg/kg **IM** / SC q 12 – 24 h	1000 mg

K9 Daily Water Requirements =
132 x Body Weight(kg)$^{0.75}$ or 40 - 50 mL/kg/day

K9 TECC Shock Fluid Resuscitation Recommendations

- Avoid large-volume isotonic crystalloid resuscitation to prevent exacerbating resuscitative injury
- Reassess perfusion parameters after each fluid bolus
- Reassess the K9 casualty frequently to check for recurrence of shock
- If shock recurs, recheck all external hemorrhage control measures to ensure that they are still effective and repeat the fluid resuscitation as outlined above.

Heat Related Illness

- Move from hot area into shade or air-conditioned area
- As feasible, remove muzzles, harnesses, tactical gear, etc.
- Place on cool surface to promote conductive cooling
- Offer cool water and encourage drinking if K9 is alert and conscious
- Start **active external cooling**
  - If air-conditioning not available, blow a circulating fan over K9 (if available)
  - Place cold compresses or ice packs (wrapped in a towel) on the head and neck as well as in the armpits (axillae) and groin; **NOTE**: avoid placing ice packs on the limbs as this shunts hot blood back to the body core.
  - Immerse in cold water bath or Douse or spray body with cold water
- Place an IV / IO catheter and start IV / IO fluids to restore perfusion
- STOP active cooling when rectal temperatures reach 103.5 - 104°F.
  - Dry K9 off, place on dry surface, avoid direct application of air on you K9 from circulating fans or air-conditioning.
- **Monitor temperature** every ten minutes for at least the next few hours as body temperature may continue dropping to the subnormal range or rise excessively again

Options for Shock Resuscitation are in the Order of Preference

1. **K9-specific Fresh or Stored Whole Blood, 450 – 500 mL** (*1 unit*)
2. **K9-specific pRBC: FFP @ 10 mL/kg** of each *(Ex: 25kg K9 = 250 mL pRBC: 250 mL FFP)*
   DO NOT give human blood products to an injured K9
3. **Colloid only** *(*low-molecular weight 130/0.4 preferred*)*: **125 - 250 mL** (5 – 10 mL/kg)
   - *Repeated in **125 mL** aliquots to achieve palpable femoral pulse.*
   - *Not to exceed of a total volume of **500 mL***
4. **Hypertonic Saline (HTS) + Synthetic Colloid**
   - **75 mL** HTS : **75 mL** Colloid = **150 mL** total volume *(5 mL/kg HTS : 5 mL/kg Colloid)*
   - Limit **HTS** to no more than **TWO** aliquots
   - **NOTE**: Avoid using HTS in situations involving *uncontrolled hemorrhage* where definitive hemostasis cannot be achieved.
   - **With concurrent TBI**: restores perfusion and provides hyperosmotic therapy
5. **Isotonic crystalloid Only**: **500 mL** (20 mL/kg)
   - Repeated in 250 – 500 mL aliquots to achieve palpable femoral pulse.
   - Not to exceed of a total volume of 1000 mL
   - **Preferred** crystalloid is a balanced, buffered isotonic solutions
     - Lactated Ringers, Plasma-Lyte A, Normosol-R - **Avoid 0.9% NaCl**

Fluid Resuscitative Goals

Discontinue fluids when the following end-points have been achieved:

Non-Hemorrhagic or Controlled Hemorrhagic Shock
- Palpable femoral pulse & improved mentation MAP = > 65 mm Hg; **SBP 80 – 90 mm Hg**

Uncontrolled / Noncompressible Hemorrhagic Shock
- Consider *Hypotensive Resuscitation*
- Palpable femoral pulse & improved mentation AND/OR **MAP = 50 - 60 mm Hg; SBP ~80 mm Hg**
- *Maintained until **definitive hemostatic** control is achieved*

Hemorrhagic Shock with Neurological Trauma (*TBI*)
- K9 casualty with an altered mental status due to suspected TBI with a weak or absent peripheral pulse:
- Resuscitate to restore & maintain a palpable femoral pulse. If BP monitoring is available, maintain a target **SBP ≥ 90 mm Hg**

VIII. MEDICATION REFERENCES

1. Mosby Paramedic (VOL. 8/2015 AHA updates)
2. AHA ACLS provider manual
3. AHA PALS provider manual
4. TCCC Guidelines
5. Clinical Practice Guidelines (CPG's)
6. Advanced Tactical Paramedic (ATP) Guidelines 10th Edition
7. Tactical Medical Emergency Protocols (TMEPS) 10th Edition

XIII. MEDICATION REFERENCE

ACTIVATED CHARCOAL	
Class	Absorbent, Antidote
Indications	Oral poisoning and medication overdose.
Contraindications	GI obstruction, GI bleed or perforation, patients with an unprotected airway
Dose & Route	**1 to 12 years:** 25 to 50 grams **>12 years and adults**: 25 to 100 grams Given PO or via NG or OG tube. Agitate contained thoroughly and mix with water to make a slurry prior to administration.
Side Effects	May induce nausea, vomiting, constipation or diarrhea.

ADENOSINE	
Class	Antidysrhythmic
Indications	PSVT refractory to vagal maneuvers, including dysrhythmias associated with bypass tracts as WPW syndrome.
Contraindications	2° or 3° AVB's, Sick Sinus Syndrome, A-fib/flutter and VT usually not converted with Adenosine.
Dose & Route	**Adult:** 6mg rapid IV push followed by a 20cc flush. 2nd dose at 12mg may be administered in 1-2 minutes 3mg IV initially for patients taking carbamazepine or dipyridamole, heart transplant, or if adenosine is being administer through a central line. **Peds:** 0.1mg/kg rapid IV push (Max= 6mg), double the 2nd and 3rd doses (Max= 12mg).
Side Effects	Transient periods of new arrhythmia after cardioversion, chest pressure/discomfort, SOB, Nausea, chest pain, Diaphoresis, Flushing, HA, Palpitations, Paresthesia's, neck discomfort

ALBUTEROL	
Class	Sympathomimetic, Bronchodilator, Beta-2 selective
Indications	Asthma, bronchospasm, exercise-induced bronchospasm, hyperkalemia
Contraindications	Hypersensitivity. Symptomatic tachycardia dysrhythmias.
Dose & Route	**Bronchospasm**: 2.5 to 5mg diluted in 3ml of NS administered by nebulizer Q 20min x3 doses or 10 to 15mg/hour as continuous nebulization **Hyperkalemia**: 10 to 20mg nebulized over 10 minutes
Side Effects	Anxiety, tremor, chest pain, diaphoresis, dizziness, HA, nausea, palpitations, restlessness, tachycardia.

AMIODARONE	
Class	Antiarrhythmic Class III
Indications	Initial treatment and prophylaxis of recurring VF and hemodynamically unstable VT.
Contraindications	Cardiogenic shock, iodine hypersensitivity, bradycardia, 2° and 3° AVB
Dose & Route	VF/VT Cardiac arrest: **Adult**: 300mg IV/IO push, second dose of 150mg IV/IO push if needed **Peds:** 5mg/kg (Max 300mg) IV/IO push, may repeat twice (Max total dose=15mg/kg) Life-Threatening arrhythmias WITH pulse: **Adult:** 150mg IV over 10 min, may repeat if necessary **Peds:** 5 mg/kg IV (Max 300mg) over 20-60 min, may repeat twice up (Max total=15mg/kg) Maintenance Infusion after return of spontaneous resuscitation: 360mg over 6°, then 540mg over 18°
Side Effects	Bradycardia, flushing, HA, hypotension (rapid infusions), Vertigo, N/V, QT prolongation, epithelial keratopathy, pulmonary toxicity

ASPIRIN	
Class	Analgesic, anti-inflammatory, anti-pyretic, anti-platelet
Indications	Mild to moderate pain or fever. Chest pain (suspected angina or AMI) Prevention of AMI or reinfarction.
Contraindications	Children with flu-like symptoms, Hypersensitivity to NSAIDS.
Dose & Route	STEMI/NSTEMI: PO: (4) 81mg chewable tablets (324mg) Or adult 325mg non-enteric coated Rectal: 600mg suppository for those who can't take PO
Side Effects	Anaphylaxis, pulmonary edema, GI bleeding, Heartburn, coma, confusion, dizziness, tinnitus.

ATROPINE	
Class	Parasympatholytic (anticholinergic) agent
Indications	Symptomatic sinus bradycardias Organophosphate or nerve gas poisoning
Contraindications	There are no contraindications listed in the manufacturer's labeling
Dose & Route	*Bradycardia:* Adult: 0.5 mg IV/IO repeat Q 3-5min (Max total dose=3mg) Peds: 0.02mg/kg IV/IO Q 3-5 min (Minimum dose=0.1mg, Max SINGLE dose=0.5mg, Max TOTAL dose=1mg) *Organophosphate and nerve gas poisoning:* Adult: 1 to 6 mg IV/IM/ET Q3-5 minutes prn, double the dose if no response from previous dose. Peds: 0.05 to 0.1mg/kg IV/IM/ET Q 5-10 minutes prn, double the dose if no response from previous dose
Side Effects	Anticholinergic effects (dry mouth, blurred vision, photophobia, urinary retention, and constipation). Dizziness, Dysrhythmias, Flushing, HA, Hot, dry skin, Nausea/vomiting. Palpatations. Tachycardia. Paradoxical bradycardia if pushed too slowly or in dose <0.5mg in adults or <0.1mg in peds.

CALCIUM CHLORIDE 10%	
Class	Electrolyte
Indications	Acute hyperkalemia, acute hypocalcemia, calcium channel and beta blocker OD, abdominal spasms associated with spider bites and portugese man-o-war stings. Magnesium sulfate OD.
Contraindications	Known or suspected digoxin toxicity
Dose & Route	Cardiac arrest or cardiotoxicity d/t hyperkalemia, hypocalcemia, or hypermagnesemia Adult: 500 to 1000mg IV over 3-5minutes, may repeat prn Peds: 20mg/kg IV/IO Max= 2000mg/dose, may repeat prn Beta-blocker OD (Refractory to first line treatments) Adult: 10% solution: 20mg/kg over 5-10min, followed by 20 to 50mg/kg/hr Ca channel blocker OD: Adult: 10% solution: 1 to 2 grams over 5 min Q10-20min, then 20 to 50mg/kg/hr Peds: 10 to 20mg/kg over 10-15min (Max=2000mg/dose) Q10-15min prn, followed by 20-50 mg/kg/hr Hypovolemic shock: Infused via a 10% solution, 1 gram over 10 minutes.
Side Effects	ADE due to rapid IV injections: bradycardia, cardiac arrest, hypotension, syncope, feeling abnormal, tingling sensation, hot flash

DEXTROSE 50% / 25%	
Class	Carbohydrate, Hypertonic solution
Indications	Altered LOC, Coma of unknown origin, Hypoglycemia (usually FSBS <70). Seizures of unknown origin.
Contraindications	Increased intracranial pressure or hemorrhage. Known or suspected CVA in absence of hypoglycemia. Hypersensitivity to corn
Dose & Route	Adult: 10 to 25G slow IVP, repeat if necessary. Peds: 0.5-1.0g/kg slow IVP. If D25 not available, dilute D50 1:1 with sterile water or saline for 25% concentration May repeat of necessary.
Side Effects	Irritation, burning, and pain at the injection site.

DIAZEPAM (Valium)	
Class	Benzodiazepine
Indications	Acute alcohol. Acute anxiety state. Pre-medication prior to counter shock or TCP. Seizure activity. Skeletal muscle relaxation.
Contraindications	Coma (except seizures or rigidity.) Respiratory depression. Acute narrow-angle glaucoma. Untreated open-angle glaucoma.
Dose & Route	Seizures (adult and peds): IV: 0.15mg/kg over 2 minutes (Max=10mg/dose). May repeat Q 5min prn Anxiety: Adult: 2 to 10 mg IV/IM; may repeat in 3-4 hours prn
Side Effects	Confusion. Drowsiness. Hypotension. N/V. Psychomotor impairment. Reflex tachycardia. Respiratory depression or arrest.

DILTIAZEM (Cardizem)	
Class	Nondihydropyridine Calcium Channel Blocker
Indications	Atrial fibrillation, flutter, and tachycardia with rapid ventricular response rate. PSVT.
Contraindications	2nd or 3rd degree AVB. AMI. Cardiogenic shock. Hypersensitivity. Hypotension. Within a few hours of IV Beta blocker use. Sick sinus syndrome. Short PR syndrome. Ventricular tachycardia. WPW syndrome. Wide complex tachycardia of unknown origin.
Dose & Route	Adult: 0.25mg/kg IV over 2 min. Repeat in 15 minutes if needed at 0.35mg/kg. Peds: Same as adult, but rarely used.
Side Effects	1st degree AVB. Bradycardia. Chest pain. CHF. Diaphoresis. Dizziness. Dyspnea. Headache. Hypotension. Nausea/vomiting. Peripheral edema

DIPHENHYDRAMINE (Benadryl)	
Class	Antihistamine
Indications	Acute extrapyramidal reactions. Dystonic reactions to phenothiazines. Moderate to severe anaphylaxis after epinepherine. Allergic symptoms.
Contraindications	Hypersensitivity. Nursing mothers.
Dose & Route	Adult: 25-50mg IM/IV Peds: 1 to 2mg/kg IM/IV (Max 50mg/dose)
Side Effects	Bradycardia. Disturbed coordination. Drowsiness. Dry mouth and throat. Paradoxical excitement in children. Sedation. Tachycardia. Thickening of bronchial secretions.

DOPAMINE (Intropin)	
Class	Sympathomimetic (Inotrope)
Indications	Adjunct treatment of Hypotension in the absence of Hypovolemia. Second line for symptomatic bradycardia (after atropine)
Contraindications	Hypovolemic shock without fluid resuscitation. Patients with Pheochromocytoma. Tachydysrhythmias. Ventricular Fibrillation.
Dose & Route	Adult and Peds: (Concentrations of 1600mcg/ml or 800mcg/ml) 400mg in 250ml=1600mcg/ml, 400mg in 500ml=800mcg/ml 800mg in 500ml=1600mcg/ml, 800mg in 1000ml=800mcg/ml *Renal Dose*: 1-5mcg/kg/min *Cardiac Dose:* 5-10mcg/kg/min *Vasopressor dose:* >10mcg/kg/min
Side Effects	Dose related tachycardia's, Hypertension, Increased myocardial O_2 demands (may increase ischemia), Palpitations, Excessive vasoconstriction

ETOMIDATE	
Class	Nonbarbituate hypnotic, anesthetic
Indications	Premedication for tracheal intubation or cardioversion.
Contraindications	Hypersensitivity
Dose & Route	Adult and Peds: 0.2-0.6mg/kg IV/IO over 30 seconds (usually 0.3mg/kg)
Side Effects	Adrenal Suppression, Apnea, Hiccups, Hypo/Hyperventilation, Pain at injection site, Bradycardia, HTN, Involuntary muscle movements, Tachycardia, Dysrhythmias, Hypotension, N/V

EPINEPHRINE	
Class	Sympathomimetic
Indications	1:1000: Anaphylaxis. Severe allergic reactions. Bronchial asthma. Exacerbation of COPD. Used in adult and pediatric cardiac arrest after 1:10,000. 1:10000: Anaphylactic Shock, Cardiac Arrest, Profound symptomatic bradycardia
Contraindications	There are no contraindications
Dose & Route	1:1000: (1 mg in 1 ml vial; See EPI 1:10,000 for cardiac arrest dosing regimens) *Hypersensitive Reactions (Intramuscular is preferred over SQ)* Adult: 0.2-0.5mg IM/SQ Q 5-15min Peds: 0.01mg/kg up to 0.3mg IM/SQ Q 5-15min 1:10000: (1mg in 10ml syringe) *Cardiac Arrest:* Adult: 1MG IVP every 3-5 Minutes (ETT 2-2.5 x IV dose) Peds: 0.1mg/kg (1:10,000) initial dose IV (0.1mg/kg of 1:1,000 ETT) Subsequent doses 0.1mg/kg of 1:1,000 IV/ET/IO *Anaphylactic reaction or bronchoconstriction:* Adult: 0.1mg over 5 minutes Peds: 0.1mcg/kg/min IV infusion (Refractory to IM dose; Max=10mcg/min) *Infusions for cardiac arrest or symptomatic Bradycardia:* Adult: Mix 2mg in 250mls of NS/D5W (8mcg/ml) and Infuse at 0.1mcg/kg/min for desired response. Peds: Mix 2mg in 250mls of NS/D5W (8mcg/ml), begin at 0.1mcg/kg/min, titrate up to 1mcg/kg/min Epinephrine Push Dose: 1/100,000 Draw 1ml of Epi 1/10,000 into 9 mL of a NS saline flush: 10mcg/ml Loading dose: 20 mcg/2ml Continuous Dosing: 10mcg/1ml/min to maintain SBP of >90 mmHg
Side Effects	Anxiousness, Chest Pain, Headache, Nausea, Palpitations, Restlessness, Tachycardia, Tremors. Tachyarrhythmia. Injection site tissue necrosis.

FENTANYL (Sublimaze)	
Class	Narcotic Analgesic
Indications	Adjunct to aesthesia for procedures, Severe pain
Contraindications	Hypersensitivity
Dose & Route	Adult: 25-100 mcg IV over 1 min Q30-60 minutes (May also give IM) Peds: 1-2 mcg/kg IV over 1 min Q30-60 minutes (May also give IM)
Side Effects	Altered LOC, Abnormal dreams, Arrhythmias, Confusion, Dizziness, Headaches, Hypotension, N/V, Respiratory depression

FUROSEMIDE	
Class	Loop diuretic
Indications	Pulmonary edema associated with CHF, hepatic or renal disease.
Contraindications	Anuria. Hypersensitivity. Hypersensitivity to sulfonamides. Hypovolemia/Dehydration. Uncorrected states of electrolyte depletion
Dose & Route	Adult: 20 to 40mg IV, may repeat in 1-2hours as same dose or increase by 20mg/dose Peds: 1mg/kg IV, May repeat in 2 hours or increase by 1mg/kg/dose (max 6mg/kg/dose)
Side Effects	Dry Mouth, ECG changes with electrolyte imbalances, Hypercalcemia, Hyperuricemia, Hypochloremia, Hyponatremia, Hypokalemia, Hypotension, Transient deafness, Tinnitus

GLUCAGON	
Class	Pancreatic Hormone, insulin antagonist.
Indications	Hypoglycemia (if D50 unavailable). Unconscious, combative, seizuring patients that an IV cannot be started and glucose is needed. Beta Blocker and Calcium Channel Blocker Overdose.
Contraindications	Hypersensitivity; pheochromocytoma, insulinoma
Dose & Route	Hypoglycemia: Adult: 1mg reconstituted IM/IV/SQ Q 15 min prn Peds: <20kg = 0.5mg, >20kg = 1mg IM/IV/SQ Q 15min prn Beta Blocker and Calcium Channel Blocker Overdose Adult: 3 to 10 mg IV bolus followed by an infusion of 3-5 mg/hr Peds: 0.15mg/kg IV bolus followed by an infusion of 0.07mg/kg/hr (Max 5mg/hr)
Side Effects	Hypotension, N/V, Tachycardia, Uticaria

IPATROPIUM (Atrovent)	
Class	Anticholinergic, Bronchodilator
Indications	Persistent bronchospasm associated with asthma and COPD.
Contraindications	Hypersensitivity to ipatropium, atropine, alkaloid, soybean products, or peanuts.
Dose & Route	Adult: 500mcg (0.5mg) in nebulizer typically with a beta adrenergic (Albuterol) Pediatrics: N/A
Side Effects	Anxiety. Blurred vision. Coughing. Dry mouth. Headache. Nausea/vomiting. Palpatations. Tachycardia.

KETOROLAC (Toradol)	
Class	NSAID
Indications	Short-term management of moderate to severe pain
Contraindications	Hypersensitivities to aspirin/NSAIDS, Active peptic ulcer disease, History of GI bleeding, Angioedema, Asthma, Renal Failure
Dose & Route	Adult: 30-60mg IM or 15-30 MG IVP Peds: Not recommended
Side Effects	Anaphylaxis, Bleeding disorders, Edema, Headache, Nausea, Sedation.

KETAMINE	
Class	Analgesic
Indications	Moderate to Severe acute and chronic pain, adjunct to aesthesia for procedures, or RSI
Contraindications	<3 months old, known or suspected schizophrenia (even if stable on current meds)
Dose & Route	Pain: Adult: IM: 2-4 mg/kg (repeat dose every 30 minutes to 1 hour as necessary to control severe pain or casualty develops nystagmus/rhythmic eye movement back and forth) IN: 0.5 to 1mg/kg (using nasal atomizer device) Q10min with 0.25-0.5mg/kg prn IV: 0.3mg/kg infused over 5 minutes Sedation: Adult and Peds: IM: 4-5 mg/kg, may repeat Q5-10 minutes prn IV: 1-2mg/kg over 1 min, may repeat 0.5-1mg/kg Q5-15 minutes prn
Side Effects	Delirium, confusion, dreamlike state, hallucinations, vivid imagery, Bradycardia, sialorrhea, nausea/vomiting, tachycardia, nystagmus, hypertension, hypertonia

LIDOCAINE 2%	
Class	Antidyrshythmic, local anesthetic
Indications	Significant ventricular ectopy in the setting of myocardial ischemia or infarction. Ventricular fibrillation. Ventricular Tachycardia.
Contraindications	2nd or 3rd degree heart block in absence of artificial pacemaker. Adams-stokes syndrome. WPW syndrome. PVC's in conjunction with bradycardia. Allergy to corn
Dose & Route	*Cardiac Arrest* (V-fib, Pulseless V-Tach): Adult: 1-1.5mg/kg IV/IO, repeat Q 5-10 minutes with 0.5-0.75mg/kg to a max of 3mg/kg May give 2-3.75mg/kg ET diluted in 5-10 ml NS or SWFI *Peds:* 1mg/kg IV/IO follow with infusion of 20- 50mcg/kg, May give 2-3 mg/kg/dose ET flushed with 5ml NS and 5 assisted manual ventilations *Maintenance infusion after conversion of rhythm:* Adult: Mix 2 grams in 500ml (4mg/ml) and infuse at 2-4mg/min. Peds: Dilute 120mg in 100ml and infuse at 20-50mcg/kg/min (1-2.5mg/kg/Hour)
Side Effects	Bradycardia, Blurred Vision, Cardiovascular collapse, CNS depression with high doses. Confusion. Hypotension. Lightheadedness.

LORAZEPAM (Ativan)	
Class	Benzodiazepine
Indications	Acute anxiety episodes, Combative patients, Difficult intubations, Muscle relaxant, Status epilepticus, Pre-medication for cardioversion or TCP.
Contraindications	Hypersensitivity. Respiratory depression. Acute narrow-angle glaucoma
Dose & Route	Adult: 2-4mg IV/IM Q5-10min (Max=4mg/dose) Pediatrics: 0.1 mg/kg IV/IM Q5-10min (Max=4mg/dose)
Side Effects	Decreased LOC. Hypotension. Respiratory depression.

MAGNESIUM SULFATE 10%	
Class	Electrolyte, Anti-Convulsant
Indications	Hypomagnesium, Pre-term labor, Seizures of ecclampsia, Torsades de Points, Refractory ventricular fibrillation.
Contraindications	Heart Block. Hypersensitivity. Hypocalacemia. Myocardial damage. Shock. Severe persistent hypertension
Dose & Route	*Seizure activity associated with pregnancy/pre-term labor:* 4-6 grams IV infused over 20 min, followed by 1-2grams/hour (Max=40g/24 hours) *Torsade/Refreactory VF,VT:* Adult: 1-2 grams IV/IO in 10 ML NS or D5W bolus if pulseless and over 15 Minutes with a pulse. Peds: 25-50mg/kg/dose IV/IO bolus if pulseless or over 20 minutes with pulse (Max=2grams/dose)
Side Effects	Bradycardia. Circulatory collapse. CNS Depression. Depressed reflex. Diaphoresis. Diarrhea. Flushing. Hypotension. Hypothermia. Respiratory depression

METHYLPREDNISOLONE (Solu-medrol)	
Class	Glucocorticoid (synthetic steroid)
Indications	Acute spinal cord injury. Anaphylaxis. Bronchodilator-unresponsive. Asthma. Shock (controversial)
Contraindications	None In emergency. Use in caution in GI bleeding, diabetes, and severe infection.
Dose & Route	Adult: 40-125mg IVP except for spinal injury which is 30mg/kg IV over 15 minutes followed by 5.4mg/kg/hour infusion. Peds: Spinal cord injury: same dose as adult Asthma Exacerbation: <12 years old; 1-2 mg/kg/day, Max=60mg/day >12 years old; Same as adult
Side Effects	Alkalosis, GI bleeding. Headache, Hypertension. Hypokalemia. Prolonged wound healing. Sodium and water retention.

MIDAZOLAM (Versed)	
Class	Benzodiazepine sedative/hypnotic
Indications	Premedication for cardioversion, RSI, Acute anxiety, status epilepticus.
Contraindications	Hypersensitivity. Acute narrow angle glaucoma.
Dose & Route	Sedation/anxiolysis Adult: IV: 2.5-5mg over 2 minutes, Q2-3min prn IM: 0.08 mg/kg IN: 0.1mg/kg Peds: IV: <6 months: Not recommended 6months-5 years: 0.05-0.1mg/kg (Max total dose= 6mg) 6-12 years old: 0.05mg/kg (Max total dose=10mg) >12 years old: Refer to Adult dosing (Max total dose=10mg) IM: 0.1-0.5mg/kg, Max total dose=10mg IN: 0.2-0.5mg/kg, Max total dose=10mg Status Epilepticus Adult: IV: 0.2mg/kg IM: 10mg once or 0.2mg/kg (Max 10mg/dose) Peds: IV: 0.2mg/kg IM: 0.2mg/kg (Max=10mg/dose)
Side Effects	AMS. Amnesia. Blurred Vision. Bradycardia. Cough. Drowsiness. Fluctuations in respiratory arrest. Respiratory depression. Tachycardia.

MORPHINE	
Class	Opioid analgesic
Indications	Chest Pain associated with MI. Moderate to Severe acute and chronic pain. Pulmonary edema with or without pain.
Contraindications	GI obstruction. Hypersensitivity. Hypotension. Hypovolemia. Patient having taken MAO inhibitors in last 14 days. Severe respiratory depression.
Dose & Route	Adult: Start 2-10mg SIVP (2mg/min) titrate to effect. Peds: 0.1-0.2mg/kg/dose SIVP Max dose: <1 year old= 2mg/dose, 1-6 years=4mg/dose, 7-12 years=8mg/dose, >12 years=10mg/dose
Side Effects	Allergic reaction, Altered mental status, Bradycardia, Bronchospasm, Dry Mouth, Euphoria, Flushing, Hypotension, Palpitations, Respiratory depression, Syncope, Tachycardia.

NALOXONE (Narcan)	
Class	Opioid antagonist
Indications	Coma of unknown origin, Decreased LOC, Known or suspected opioid overdose.
Contraindications	Hypersensitivity
Dose & Route	Adult: 0.4-2mg IV (preferred), IM, SC, and ET (2-2.5 times IV dose). Q 2 minutes (Max=10mg total) Peds: 0.1mg/kg IV (preferred), IM, SC, ET, or IO. (Max=2mg/dose) Q2 minutes
Side Effects	Blurred Vision, Diaphoresis, Dysrhythmias, Hypertension, N/V, Tachycardia, Withdrawal symptoms.

NITROGLYCERINE	
Class	Vasodilator, Antianginal agent, Extravasation antidote
Indications	AMI, CHF with pulmonary edema, Hypertensive emergencies, Ischemic chest pain, Pulmonary Hypertension.
Contraindications	Children under 12. Head injury with/without hemorrhage. Hypersensitivity to nitrates. Hypotension. Concurrent use with PDE-5 inhibitors. Corn allergy
Dose & Route	Adult: 0.3 or 0.6mg tablet or spray SL every 5 minutes to a total of 3 doses. IV Infusion: Mix 100-200mcg/ml drip and infuse at a rate of 5-20mcg/min to start. Increase at 5-10mcg/min every 5 minutes until desired effect is achieved or hypotension occurs. (Max=400mcg/min) Peds: N/A
Side Effects	Diaphoresis, Dizziness, Headache, Hypotension, N/V, Reflex tachycardia, syncope.

ONDANSETRON (ZOFRAN)	
Class	Antiemetic
Indications	Nausea & Vomiting
Contraindications	Hypersensitivity to dolasetron, granisetron. May precipitate with bicarb.
Dose & Route	Adult: 4-8mg IV/IO Slowly or IM. 8mg PO. Ped: 0.1mg/kg Slow IV/IO or IM. Max dose 4mg.
Side Effects	H/A, diarrhea, Fever, dizziness, pain, seizure, EPS, QT prolongation.

PROMETHAZINE (Phenegran)	
Class	Phenothiazine, Antihistamine, Antiemetic
Indications	Allergic Reactions, Motion Sickness, N/V, Pre/Post-Operative and obstetric sedation, potentiate analgesic effects
Contraindications	CNS depression from alcohol, barbiturates or narcotics. Comatose states, Hypersensitivity, Signs of Reye's Syndrome. Children <2 years old
Dose & Route	Adult: 12.5-25mg IVP/IM Peds: 0.5mg/kg IV/IM(Max=25mg/dose)
Side Effects	Tissue injury, Dizziness, Dysrhythmias, Dystonias, Hyperexcitability, Impairment of mental and physical ability, N/V, Sedation, Tachycardia / Bradycardia. Use in children may cause hallucinations, convulsions, and sudden death.

RACEMIC EPINEPHERINE	
Class	Sympathomimetic
Indications	Croup, laryngeal edema
Contraindications	Oral inhalation. Concurrent use or within 2 weeks of MAO inhibitors
Dose & Route	Adult: 0.5ml in 3-5ml saline nebulized Peds: 0.05-0.1 ML/kg in 3-5 salin nebulized (Max=0.5ml/dose)
Side Effects	Anxiety, HA, palpitations

ROCURONIUM	
Class	Neuromuscular blocker (non-depolarizing)
Indications	Adjunct to general anesthesia. Facilitation of endotracheal intubation. Maintenance of paralysis after intubation to assist ventilations.
Contraindications	Hypersensitivity
Dose & Route	Adult and Peds: 0.6-1.2 mg/kg IV
Side Effects	Apnea, Bradycardia, Hypo/Hypertension, Prolonged paralysis.

SODIUM BICARBONATE	
Class	Buffer, Alkalinizing agent, electrolyte supplement.
Indications	Alkalinization for treatment of specific intoxication's, Intubated patients with long arrest interval, PEA, Known or pre-existing bicarb responsive acidosis, Management of metabolic acidosis, Return circulation after long arrest interval, Tricyclic antidepressant OD. Hyperkalemia.
Contraindications	Abdominal pain of unknown origin, Hypocalcemia, Hypernatrenua, Alkalosis
Dose & Route	Adult: Cardiac Arrest: 1mEq/kg SIVP, repeat doses should be guided by arterial blood gases Hyperkalemia: 50meq IV over 5 minutes Peds: Cardiac Arrest/Hyperkalemia: (> two years of age) Same as Adult Infants: (< two years of age) 4.2% solution is recommended for IV administration Slow administration rates and the 4.2% solution are recommended in neonates, to guard against the possibility of producing hypernatremia, decreasing cerebrospinal fluid pressure, and inducing intracranial hemorrhage. Tricyclic Antidepressant Overdose: 1-2 mEq/kg IV boluses Q5-10min followed by an continuous infusion of 150meq/L solution to maintain alkalosis
Side Effects	Electrolyte Imbalance. Hypoxia, Metabolic alkalosis. Rise in intracellular PcO_2 and increased tissue acidosis. Seizures. Tissue sloughing at injection site.

SODIUM CHLORIDE	
Class	Isotonic IV fluid
Indications	Dehydration / Hypovolemia, Diabetic Ketoacidosis, Heat related emergency, Hypotension, Medication route.
Contraindications	CHF. Pulmonary edema. Severe electrolyte imbalance
Dose & Route	Adult: KVO for maintenance of drug route. 250-500 ml bolus for fluid resuscitation. Repeat as needed. Peds: 20ml/kg bolus repeat as needed.
Side Effects	Electrolyte imbalance. Pulmonary edema from overload.

SUCCINYLCHOLINE	
Class	Neuromuscular blocker (depolarizing)
Indications	Muscle relaxation. Terminate laryngospasm, facilitate intubation
Contraindications	Acute injuries, Acute rhabdomyolsis, Hypersensitivity, Inability to control airway or ventilate patient, Personal or family Hx of malignant hyperthermia, Skeletal muscle myopathies.
Dose & Route	Adult: 1-1.5mg/kg IVP over 10-30 seconds or 3 to 4 mg/kg IM Peds: Same as adult
Side Effects	Allergic Reaction, Bradycardia, Dysrhythmias, Excessive salivation, Hypotension, Initial muscle fasciculations, Malignant hyperthermia, May exacerbate hyperkalemia in trauma patients, Respiratory depression

THIAMINE	
Class	Vitamin B1
Indications	Beriberi. Delirium tremors. Wernicke's Encephalopathy.
Contraindications	None
Dose & Route	Adult: 100-250mg SIVP over 30 min for doses >100mg Peds: Rarely indicated
Side Effects	Allergic reactions (rare). Anxiety. Diaphoresis. Hypotension from rapid injection or large dose. N/V

VECURONIUM	
Class	Neuromuscular blocker (non-depolarizing)
Indications	Adjunct to anesthesia. Facilitation of endotracheal intubation. Maintenance of paralysis after intubation to assist ventilations.
Contraindications	Hypersensitivity to the drug or bromides.
Dose & Route	Adult and Peds: 0.1-0.2mg/kg IVP bolus
Side Effects	Apnea, Bradycardia, Hypotension, Prolonged paralysis.

IX. LABORATORY REFERENCE

(Mosby Paramedic (VOL. 7/2010 AHA updates))

HEMATOLOGY VALUES

*HCT (HEMATOCRIT) - *Measures relative volume of cells and plasma in blood. Low values suggest hemorrhage or anemia. High values suggest polycythemia or dehydration.*
Normal Adult Male Range 40 - 54%
Normal Adult Female Range: 37 - 47%
Normal Newborn Range: 50 - 62%

*HGB (HEMOGLOBIN) - *Measures Oxygen carrying capacity of blood. Low values suggest Hemorrhage or anemia, high values suggest polycythemia.*
Normal Adult Male Range: 14 - 18 g/dl
Normal Adult Female Range: 12 - 16 g/dl
Normal Newborn Range: 14 - 20 g/dl

*RBC (RED BLOOD CELL COUNT) - *Measures the number of red blood cells. RBCs transport hemoglobin, which carries oxygen. The amount of oxygen body tissues receive depends on the amount and function of RBCs and hemoglobin. RBCs normally survive about 120 days in the blood. They are then removed by specialized "clean-up" cells in the spleen and liver.*
Normal Adult Male Range: 4.2 - 5.6 mill/mcl
Normal Adult Female Range: 3.9 - 5.2 mill/mcl
Lower ranges are found in Children, newborns and infants

*WBC (WHITE BLOOD CELL COUNT) - *Measures defense against inflammatory agents. Low values suggest aplastic anemia, drug toxicity, specific infections. High values suggest inflammation, trauma, toxicity, leukemia.*
Normal Adult Range: 3.8 - 10.8 thous/mcl
Higher ranges are found in children, newborns and infants.

*PLATELET COUNT - *A platelet count is often ordered as a standard part of a complete blood count and is almost always ordered when a patient has unexplained bruises or takes what appears to be an unusually long time to stop bleeding from a small cut or wound.*
Normal Adult Range: 150 - 450 thous/mcl
Higher ranges are found in children, newborns and infants

ELECTROLYTE VALUES

*SODIUM - *Sodium is the most abundant cation in the blood and it's chief base. It functions in the body to maintain osmotic pressure, acid-base balance and to transmit nerve impulses.*
Normal Adult Range: 135-146 mEq/L

*POTASSIUM - *Potassium is the major intracellular cation.*
Normal Range: 3.5 - 5.5 mEq/L

*SODIUM/POTASSIUM
Normal Adult Range: 26 - 38 (calculated)

*CO2 (CARBON DIOXIDE) - *The CO_2 level is related to the respiratory exchange of carbon dioxide in the lungs and is part of the buffer system. Generally when used with the other electrolytes, it is a good indicator of acidosis and alkalinity.*
Normal Adult Range: 22-32 mEq/L
Normal Childrens Range - 20 - 28 mEq/L

IX. LABORATORY REFERENCE

*ANION GAP (SODIUM + POTASSIUM – CO_2 + CHLORIDE) - *An increased measurement is associated with metabolic acidosis due to the overproduction of acids. Decreased levels may indicate metabolic alkalosis due to the overproduction of alkaloids.* Normal Adult Range: 4 - 14 (calculated)

PROTEIN

*PROTEIN, TOTAL - *Decreased levels may be due to poor nutrition, liver disease, malabsorption, diarrhea, or severe burns. Increased levels are seen in lupus, liver disease, chronic infections, alcoholism, leukemia, tuberculosis amongst many others.*
Normal Adult Range: 6.0 -8.5 g/dl

*ALBUMIN - *Major constituent of serum protein (usually over 50%). High levels are seen in liver disease (rarely), shock, dehydration, or multiple myeloma. Lower levels are seen in poor diets, diarrhea, fever, infection, liver disease, inadequate iron intake, third-degree burns and edemas or hypocalcemia*
Normal Adult Range: 3.2 - 5.0 g/dl

HEPATIC ENZYMES

AST (SERUM GLUTAMIC-OXALOCETIC TRANSAMINASE - SGOT) - *Found primarily in the liver, heart, kidney, pancreas, and muscles. Seen in tissue damage - especially damage to the heart and liver.*
Normal Adult Range: 0 - 42 U/L

ALT (SERUM GLUTAMIC-PYRUVIC TRANSAMINASE - SGPT) - *Decreased SGPT in combination with increased cholesterol levels is seen in cases of a congested liver. Increased levels seen in mononucleosis, alcoholism, liver damage, kidney infection, chemical pollutants or myocardial infarction*
Normal Adult Range: 0 - 48 U/L

ALKALINE PHOSPHATASE - *Used as a tumor marker elevated levels seen in bone injuries, pregnancy, or skeletal growth. Low levels are sometimes found in hypoadrenia, protein and vitamin deficiency, and malnutrition.*
Normal Adult Range: 20 - 125 U/L
Normal Children's Range: 40 - 400 U/L

GGT (GAMMA-GLUTAMYL TRANSPEPTIDASE) - *Elevated levels seen with liver disease, alcoholism, bile-duct obstruction, cholangitis, drug abuse, and hypermagnesemia. Decreased levels can be found in hypothyroidism, hypothalamic malfunction and hypomagnesemia.*
Normal Adult Male Range: 0 - 65 U/L
Normal Adult Female Range: 0 - 45 U/L

LDH (LACTIC ACID DEHYDROGENASE) - *Increases are usually found in cellular death and/or leakage from the cell or in some cases it can be useful in confirming myocardial or pulmonary infarction (in conjunction with other tests). Decreased levels of the enzyme may indicate malnutrition, hypoglycemia, adrenal exhaustion or low tissue or organ activity.*
Normal Adult Range: 0 - 250 U/L

*BILIRUBIN, TOTAL - *Elevated in liver disease, mononucleosis, hemolytic anemia, low levels of exposure to the sun, and toxic effects to some drugs, decreased levels are seen in people with an inefficient liver, excessive fat digestion, and possibly a diet low in nitrogen bearing foods*
Normal Adult Range 0 - 1.3 mg/dl

IX. LABORATORY REFERENCE

RENAL RELATED

*B.U.N. (BLOOD UREA NITROGEN) - *Increases can be caused by excessive protein intake, kidney damage, certain drugs, low fluid intake, intestinal bleeding, and exercise or heart failure. Decreased levels may be due to a poor diet, malabsorption, liver damage or low nitrogen intake.*
Normal Adult Range: 7 - 25 mg/dl

*CREATININE - *Low levels are sometimes seen in kidney damage, protein starvation, liver disease or pregnancy. Elevated levels are sometimes seen in kidney disease due to the kidneys job of excreting creatinine, muscle degeneration, and some drugs involved in impairment of kidney function.*
Normal Adult Range: .7 - 1.4 mg/dl

*URIC ACID - *High levels are noted in gout, infections, kidney disease, alcoholism, high protein diets, and with toxemia in pregnancy. Low levels may indicate kidney disease, malabsorption, liver damage or an acidic kidney.*
Normal Adult Male Range: 3.5 - 7.5 mg/dl
Normal Adult Female Range: 2.5 - 7.5 mg/dl

*BUN/CREATININE - *This calculation is a good measurement of kidney and liver function.*
Normal Adult Range: 6 -25 (calculated)

CARDIAC

*CREATINE PHOSPHOKINASE (CK) - *Levels rise 4 to 8 hours after an acute MI, peaking at 16 to 30 hours and returning to baseline within 4 days*
25-200 U/L
32-150 U/L

*CK-MB CK ISOENZYME - *It begins to increase 6 to 10 hours after an acute MI, peaks in 24 hours, and remains elevated for up to 72 hours.*
< 12 IU/L if total CK is <400 IU/L
<3.5% of total CK if total CK is >400 IU/L

*(LDH) LACTATE DEHYDROGENASE - Total LDH will begin to rise 2 to 5 days after an MI; the elevation can last 10 days.
140-280 U/L

LDH-1 and LDH-2 (LDH ISOENZYMES) - *Compare LDH 1 and LDH 2 levels. Normally, the LDH-1 value will be less than the LDH-2. In the acute MI, however, the LDH 2 remains constant, while LDH 1 rises. When the LDH 1 is higher than LDH 2, the LDH is said to be flipped, which is highly suggestive of an MI. A flipped pattern appears 12-24 hours post MI and persists for 48 hours.*
LDH-1 18%-33%
LDH-2 28%-40%

*MYOGLOBIN - *Early and sensitive diagnosis of myocardial infarction in the emergency department This small heme protein becomes abnormal within 1 to 2 hours of necrosis, peaks in 4-8 hours, and drops to normal in about 12 hours.*
< 1

*TROPONIN COMPLEX - Peaks in 10-24 hours, begins to fall off after 1-2 weeks.
< 0.4

X. ***REFERENCES***

The following materials have been used to provide information in this Medical Handbook:

1. Mosby Paramedic (VOL. 8/2015 AHA updates)
2. AHA ACLS 2015
3. AHA PALS 2015
4 CoTCCC Guidelines
5. Special Operations Advanced Tactical Paramedics Protocols (ATP 10th edition)
6. Tidewater Emergency Services Protocols Guide (TEMS 2017)
7. Lehne Pharmacology for Nurses
8. INFORMED ALS Field Guide (2016)
9. Dublin Rapid Interpretation of EKG's (Published 2016)
10. Advanced Trauma Life Support (ATLS)
11. Pre-hospital Trauma Life Support – Military Edition (PHTLS - Vol. 9)
12. Brady Tactical Emergency Medical Care (Published 2015)
13. Critical Care Emergency Medicine Guide
14. Emergency War Surgery Guide 4th Edition
15. COMNAVAIRFORINST 6000.2
16. BUMED Sick Call Screeners Guide and Lesson Plan
17. Pararescue Medical Operations Handbook
18. CoERCCC / Clinical Practice Guidelines

XI. Military Acute Concussion Evaluation (MACE) 2nd Edition

MACE 2
Military Acute Concussion Evaluation

Use MACE 2 as close to time of injury as possible.

Service Member Name: _____

DoDI/EDIPI/SSN: _____ Branch of Service & Unit: _____

Date of Injury: _____ Time of Injury: _____

Examiner: _____

Date of Evaluation: _____ Time of Evaluation: _____

Purpose: MACE 2 is a multimodal tool that assists providers in the assessment and diagnosis of concussion. The scoring, coding and steps to take after completion are found at the end of the MACE 2.

Timing: MACE 2 is most effective when used as close to the time of injury as possible. The MACE 2 may be repeated to evaluate recovery.

RED FLAGS

Evaluate for red flags in patients with Glasgow Coma Scale (GCS) 13-15.

- ❑ Deteriorating level of consciousness
- ❑ Double vision
- ❑ Increased restlessness, combative or agitated behavior
- ❑ Repeat vomiting
- ❑ Results from a structural brain injury detection device (if available)
- ❑ Seizures
- ❑ Weakness or tingling in arms or legs
- ❑ Severe or worsening headache

Defer MACE 2 if any red flags are present. Immediately consult higher level of care and consider urgent evacuation according to evacuation precedence/Tactical Combat Casualty Care (TCCC).

- ❑ **Negative for all red flags**
  Continue MACE 2, and observe for red flags throughout evaluation.

MACE 2 - Military Acute Concussion Evaluation

MILITARY ACUTE CONCUSSION SCREENING

Complete this section to determine if there was an injury event AND an alteration of consciousness or memory.

1. Description of Incident

A. Record the event as described by the service member or witness.

Use open-ended questions to get as much detail as possible.

_____

_____

_____

_____

Key questions:

- ❑ Can you tell me what you remember?
- ❑ What happened?
- ❑ Who were you last with?

B. Observable Signs

At the time of injury were any of these observable signs witnessed?
Visual clues that suggest a possible concussion include:

- ❑ Lying motionless on the ground
- ❑ Slow to get up after a direct or indirect blow to the head
- ❑ Disorientation, confusion, or an inability to respond appropriately to questions
- ❑ Blank or vacant look
- ❑ Balance difficulties, stumbling, or slow labored movements
- ❑ Facial injury after head trauma
- ❑ Negative for all observable signs

C. Record the type of event.

Check all that apply:

- ☐ Blunt object
- ☐ Sports injury
- ☐ Gunshot wound
- ☐ Fall
- ☐ Assault
- ☐ Explosion/blast Estimated distance ____
- ☐ Fragment
- ☐ Motor vehicle crash
- ☐ Other _____

D. Was there a blow or jolt to the head?

- ❑ Did your head hit any objects?
- ❑ Did any objects strike your head?
- ❑ Did you feel a blast wave? (A blast wave that is felt striking the body or head is considered a blow to the head.)
- ❑ Did you have a head acceleration or deceleration?

☐ **YES** ☐ **NO** ☐ **UNKNOWN**

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MACE 2 - Military Acute Concussion Evaluation

2. Alteration of Consciousness or Memory

A. Was there alteration of consciousness (AOC)?
AOC is temporary confusion or "having your bell rung."

☐ YES ☐ NO

If yes, for how long? ____ seconds
____ minutes

☐ UNKNOWN

Key questions:
- ❑ Were you dazed, confused, or did you "see stars" immediately after the event?
- ❑ Did you feel like you were in a fog, slowed down, or "something was not right"?

B. Was there loss of consciousness (LOC)?
LOC is temporarily passing out or blacking out.

☐ YES ☐ NO

If yes, for how long? ____ seconds
____ minutes

☐ UNKNOWN

Key questions:
- ❑ Did you pass out or black out?
- ❑ Is there a period of time you cannot account for?

C. Was there any post traumatic amnesia (PTA)?
PTA is a problem remembering part or all of the injury events.

☐ YES ☐ NO

If yes, for how long? ____ seconds
____ minutes

☐ UNKNOWN

Key questions:
- ❑ Is there a period of time you cannot account for?
- ❑ What is the last thing you remember before the event?
- ❑ What is the first thing you remember after the event?

D. Was the AOC, LOC or PTA witnessed?

☐ YES ☐ NO

If yes, for how long? ____ seconds
____ minutes

☐ UNKNOWN

Tips for assessment:
- ❑ Ask witness to verify AOC, LOC or PTA and estimate duration.

3. Symptoms

Common symptoms after a concussion are listed below. For this event, check all that apply.

- ❑ Headache
- ❑ Dizziness
- ❑ Memory problems
- ❑ Balance problems
- ❑ Nausea/vomiting
- ❑ Difficulty concentrating
- ❑ Irritability
- ❑ Visual disturbances
- ❑ Ringing in the ears
- ❑ Other _____
- ❑ **Negative for all symptoms**

4. History

A. During the past 12 months, were you diagnosed with a concussion, not counting this event?

☐ YES ☐ NO

If yes, how many? ____

☐ UNKNOWN

B. History of diagnosed/treated headache disorder or migraine.

☐ YES ☐ NO

C. History of depression, anxiety, or other behavioral health concerns.

☐ YES ☐ NO

CONCUSSION SCREENING RESULTS (Possible Concussion?)

Was there a blow or jolt to the head (1D)
AND
ANY alteration of consciousness or memory? (2A, 2B, 2C, or 2D)

YES (to both) ⬇

POSITIVE CONCUSSION SCREEN:

1. **Continue** MACE 2.
2. Complete evaluation before prescribing rest.
3. Communicate findings to line leadership.
4. Document and code findings in electronic health record (EHR).

NO (to either or both) ⬇

NEGATIVE CONCUSSION SCREEN:

1. **Stop** MACE 2.
2. Initiate 24 hour-rest period, if deployed. During rest, avoid activities that worsen symptoms. Follow up with the service member after rest period per concussion management tool (CMT).
3. Communicate findings to line leadership.
4. Document and code findings in electronic health record (EHR).

COGNITIVE EXAM

5. Orientation

Score one point for each correct response.

Ask This Question	Incorrect	Correct
"What month is this?"	0	1
"What is the date or day of the month?"	0	1
"What day of the week is it?"	0	1
"What year is it?"	0	1
"What time do you think it is?"	0	1
Correct response must be within one hour of actual time.		

ORIENTATION TOTAL SCORE ____/5

6. Immediate Memory

Choose one list (A-F below) and use that list for the remainder of the MACE 2.

Read the script for each trial and then read all five words. Circle the response for each word for each trial. Repeat the trial three times, even if the service member scores perfectly on any of the trials.

Trial 1 script: Read the script exactly as written.

- *"I am going to test your memory. I will read you a list of words and when I am done, repeat back to me as many words as you can remember, in any order."*

Trials 2 and 3 script: Read the script exactly as written.

- *"I am going to repeat that list again. Repeat back to me as many words as you can remember, in any order, even if you said them before."*

	Trial 1		Trial 2		Trial 3	
List A	Incorrect	Correct	Incorrect	Correct	Incorrect	Correct
Jacket	0	1	0	1	0	1
Arrow	0	1	0	1	0	1
Pepper	0	1	0	1	0	1
Cotton	0	1	0	1	0	1
Movie	0	1	0	1	0	1

IMMEDIATE MEMORY TOTAL SCORE ____/15

Immediate Memory Alternate Word Lists

List B	List C	List D	List E	List F
Dollar	Finger	Baby	Candle	Elbow
Honey	Penny	Monkey	Paper	Apple
Mirror	Blanket	Perfume	Sugar	Carpet
Saddle	Lemon	Sunset	Sandwich	Saddle
Anchor	Insect	Iron	Wagon	Bubble

COGNITIVE EXAM - Continued

15. Concentration - Continued

B. Months in Reverse Order

Script: Read the script exactly as written.

- *"Now tell me the months of the year in reverse order. Start with the last month and go backward. So you'll say: December, November…Go ahead."*

Correct Response:
Dec – Nov – Oct – Sep – Aug – Jul – Jun – May – Apr – Mar – Feb – Jan

	Incorrect	Correct
ALL months in reverse order	0	1

MONTHS IN REVERSE ORDER (16B) ____/1

CONCENTRATION TOTAL SCORE ____/5
Sum of scores:
15A (0-4 points) and 15B (0 or 1 point)

16. Delayed Recall

Read the script and circle the response for each word.
Do NOT repeat the word list.
Note: Use the same list (A-F) that was used in Question 6.

Script: Read the script exactly as written.

- *"Do you remember that list of words I read a few minutes earlier? I want you to tell me as many words from that list as you can remember. You can say them in any order."*

List A	Incorrect	Correct
Jacket	0	1
Arrow	0	1
Pepper	0	1
Cotton	0	1
Movie	0	1

DELAYED RECALL TOTAL SCORE ____/5

Delayed Recall Alternate Word Lists

List B	List C	List D	List E	List F
Dollar	Finger	Baby	Candle	Elbow
Honey	Penny	Monkey	Paper	Apple
Mirror	Blanket	Perfume	Sugar	Carpet
Saddle	Lemon	Sunset	Sandwich	Saddle
Anchor	Insect	Iron	Wagon	Bubble

17. Vestibular/Ocular-Motor Screening (VOMS) for Concussion Instructions

VOMS Contraindication: Unstable Cervical Spine.

Consider defering VOMS if patient is overtly symptomatic or a trained provider unavailable. VOMS should be completed before return to duty. Use comment section for any provider-observed difficulty with specific VOMS tasks.

A. **Baseline symptoms.** Record headache, dizziness, nausea and fogginess (HDNF), on zero to 10 scale prior to screening.

B. **Smooth pursuits**. Service member and examiner are seated. Hold fingertip three feet from patient. Service member focuses on fingertip target as examiner moves fingertip smoothly horizontally one and a half feet right and left of midline at rate requiring two seconds to go fully from left to right and right to left. Perform twice. Repeat in vertical direction one and a half feet above and one and a half feet below midline up and down, moving eyes two seconds fully up and two seconds down. Perform twice. Record HDNF on a zero to 10 scale.

C. **Saccades**. Service member and examiner are seated.

1) **Horizontal saccades:** Hold two fingertips horizontally at a distance of three feet from service member, and one and a half feet left and right of midline so service member gazes 30 degrees left and right. Service member moves eyes as quickly as possible from point to point. Perform 10 times. Record HDNF on a zero to 10 scale.

2) **Vertical saccades:** Repeat with two fingertips vertically three feet from service member, and one and a half feet above and below midline so service member gazes 30 degrees upward and downward. Service member moves eyes as quickly as possible from point to point. Perform 10 times. Record HDNF on a zero to 10 scale.

D. **Convergence**. Service member and provider are seated facing each other. Service member focuses on font target (page 14) at arm's length and slowly brings toward tip of nose. Service member stops target when two distinct images seen or when outward deviation of eye observed. Repeat and measure three times. Record centimeters between target and tip of nose for each trial. A near point of convergence ≥ five centimeters from the tip of the nose is considered abnormal. Record HDNF on a zero to 10 scale.

17. Vestibular/Ocular-Motor Screening (VOMS) for Concussion Instructions (Continued)

E. Vestibular-ocular reflex (VOR) test. Service member and examiner are seated. Examiner holds font target (page 14) in front of service member in midline at three feet, rotation speed set with metronome.

1) **Horizontal VOR test:** Service member rotates head horizontally focusing on target at 20 degrees to each side. Rotation = 180 beats per minute (bpm). Perform 10 times. Record: HDNF 10 seconds after test.

2) **Vertical VOR test:** Repeat test moving head vertically 20 degrees up and down at 180 bpm. Perform 10 times. Record HDNF 10 seconds after test.

F .Visual motion sensitivity (VMS) test. Service member stands with feet shoulder width apart, facing a busy area. Examiner stands next to and slightly behind service member. Service member outstretches arm. Focusing on their thumb, the service member rotates head,eyes and trunk as unit 80 degrees right and left. Rotation = 50 bpm. Perform five times. Record HDNF on a zero to 10 scale.

17. VOMS Score Card

Vestibular/Ocular Motor Test:	Not Tested	Headache 0-10	Dizziness 0-10	Nausea 0-10	Fogginess 0-10	Comments
BASELINE SYMPTOMS:	N/A					
Smooth Pursuits						
Saccades – Horizontal						
Saccades – Vertical						
Convergence (Near Point)						(Near Point in cm): Measure 1: _____ Measure 2:_____ Measure 3:_____
VOR – Horizontal						
VOR – Vertical						
Visual Motion Sensitivity Test						
Total						

Any score above baseline is considered abnormal

VOMS RESULTS

☐ All Normal ☐ Any Abnormal

MACE 2 - Military Acute Concussion Evaluation

EXAM SUM-

Record the data for correct MACE 2 documentation.

Cognitive Summary

Orientation Total Score - Q5	/5
Immediate Memory Total Score (all 3 trials) **- Q6**	/15
Concentration Total Score (Sections A and B) **- Q15**	/5
Delayed Recall Total Score - Q16	/5
COGNITIVE RESULTS ≤ 25 is abnormal	/30

NEUROLOGICAL RESULTS (Q 7-14)	☐ Abnormal (+)	☐ Normal (-)
SYMPTOM RESULTS (Q 3)	☐ 1 or more symptoms (+)	☐ No symptoms (-)
HISTORY RESULTS (Q 4A-4C)	☐ Positive (+)	☐ Negative (-)

VOMS RESULTS (Q 17)	☐ Abnormal (+)	☐ Normal (-)	☐ Deferred
MACE 2 RESULTS		☐ Positive (+)	☐ Negative (-)

AFTER COMPLETING MACE 2:

- ❑ Document MACE 2 results in the EHR with coding instructions.
- ❑ Initiate 24-hour rest.
- ❑ Refer to concussion management tool for the management recommendations based on MACE 2 results.
- ❑ After 24-hour rest period, evaluate for initiation into the Progressive Return to Activity (PRA) following the guidance of the PRA Clinical Recommendation.

  Refer to Progressive Return to Activity Clinical Tool at dvbic.dcoe.mil/files/resources/2013_PRA_PCM_CST_FINAL.pdf

VOMS Equipment Sample 14 point font: **A**

TBI CODING INSTRUCTIONS

Initial TBI screening code*: Z13.850
TBI coding sequence:

1. **Primary TBI diagnostic code: S06. E L S E****
2. **Primary symptom code,** if applicable: (e.g., H53.2 - diplopia)
3. **Deployment status code,** if applicable:*** (e.g., Z56.82 for deployed or Z91.82 for history of military deployment)
4. **TBI external cause of morbidity code:** (For example, Y36.290A (A- use for initial visit) for war operations involving other explosions and fragments, military personnel, initial encounter)
5. Place of occurrence code, if applicable
6. **Activity code,** if applicable
7. **Personal History of TBI code:** if applicable Z87.820

* MACE 2
** Etiology, Location, Severity, Encounter
*** Deployment code must fall within the first four codes when applicable

For more information, see DVBIC ICD-10 Coding Guidance Tool.

References available at https://dvbic.dcoe.mil/material/military-acute-concussion-evaluation-2-mace-2-reference-list.

We are authorized to collect the information on this form and any supporting documentation, including social security numbers, under the Patient Protection and Affordable Care Act (Public Law No. 111-148), as amended by the Health Care and Education Reconciliation Act of 2010 (Public Law No. 111-152), and the Social Security Act.

THIS TOOL MAY BE COPIED FOR CLINICAL USE.

PUID 4901
Released: February 2012 | Revised October 2018
by Defense and Veterans Brain Injury Center.
This product is reviewed annually and is current until superseded.

XII. NOTES

QUICK CONVERSIONS

CONVERSION CHARTS

Length Conversions

1 inch = 2.54 cm	1 mm = 0.1 cm = 0.039 in
1 foot = 30.5 cm = 0.305 m	1 cm = 10 mm = 0.39 in
1 yard = 0.91 m	1 m = 100 cm = 39 in
1 mile = 1.6 km	1 km = 100 m = 1093 yd

Weight Conversions

1 oz = 30 g	1 g = 001 kg = 0.36 oz
1 lb = 16 oz = 0.45 kg	1 kg = 1000 g = 2.2 lbs
1 ton = 2000 lbs = 907 kg	1 ton (metric) = 1000 kg = 2200 lbs
1 grain = 65 mg	

Volume Conversions

1 fl oz = 30 ml = 30 cc	1 cc = 0.001 liter
1 US Gal = 128 fl oz = 3785 ml	1 ml = 1 cc = 0.34 fl oz
	1 liter = 1000 ml = 340 fl oz

Conversion Formulas

WEIGHT	LENGTH
lb = kg X 2.2	Lnches = cm X 0.394
kg = lb X 0.45	c = inches X 2.54

TEMPERATURE

F = (1.8) X C + 32

C = (F – 32) / (1.8)

Quick Conversions

HEIGHT			WEIGHT		TEMPERATURE	
ft/in	in	cm	lb	kg	F	C
4'8"	56	142	40	18.2	212	100
4'9"	57	145	50	22.7	108	42.2
4'10"	58	147	60	27.3	107	41.6
4'11"	59	150	70	31.8	106	41.1
5'0"	60	152	80	36.4	105	40.6
5'1"	61	155	90	40.9	104	40.0
5'2"	62	157	100	45.5	103	39.4
5'3"	63	160	110	50.0	102	38.9
5'4"	64	163	120	54.5	101	38.3
5'5"	65	165	130	59.1	100	37.8
5'6"	66	168	140	63.6	99	37.2
5'7"	67	170	150	68.2	98	36.7
5'8"	68	173	160	72.7	98.6	37.0
5'9"	69	175	170	77.3	97	36.1
5'10"	70	178	180	81.8	96	35.6
5'11"	71	180	190	86.4	95	35.0
6'0"	72	183	200	90.9	94	34.4
6'1"	73	185	210	95.5	93	34.0
6'2"	74	188	225	102.3	92	33.3
6'3"	75	191	250	113.6	91	32.8
6'4"	76	193	275	125.0	90	32.1
6'5"	77	196	300	136.4		

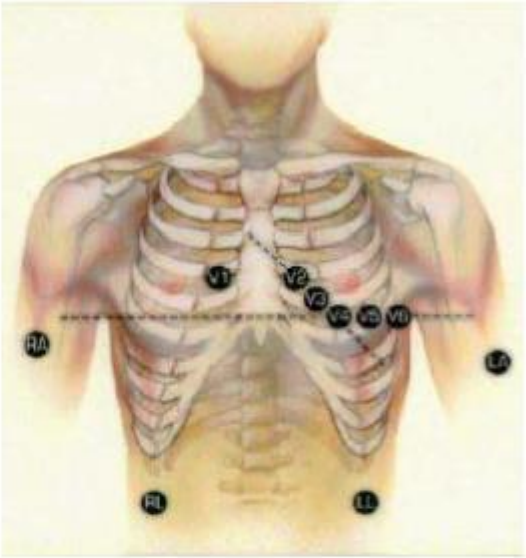
IV FLUID RATES IN DROPS PER MINUTE

ml/HR	50	75	80	100	125	150	175	200	250
10GTT-	8	13	13	17	21	25	29	33	42
15GTT-	12	19	20	25	31	37	44	50	62
60GTT-	50	75	80	100	125	150	175	200	250

12-Lead ECG

INDICATIONS (EMT, A, I, P)

- Suspected cardiac patient
- Suspected overdose
- Electrical injuries
- Syncope/Near-Syncope
- CHF
- Nausea/Vomiting
- Chest Pain
- Shortness of Breath
- Abdominal Pain
- Upper back pain (non-muscular)
- Weakness
- Toxic exposures
- Atypical presentations



PROCEDURE

Standard

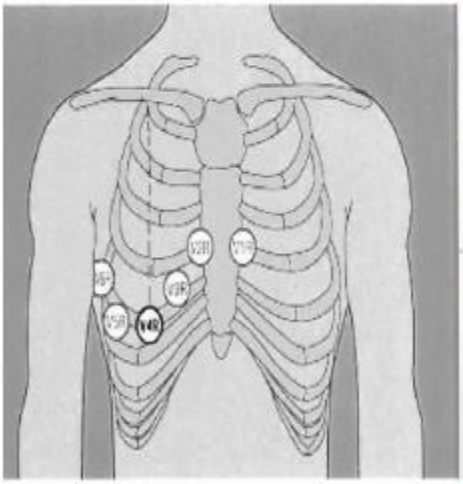
1. Prepare 12-Lead ECG monitor and connect patient cable with electrodes
2. Expose chest and prep as necessary. Modesty of the patient should be respected
3. Apply chest leads and extremity leads using the following landmarks:
    - RA- Right arm
    - LA- Left arm
    - RL- Right Leg
    - LL- Left Leg
    - V1- 4th intercostal space at right sternal border
    - V2- 4th intercostal space at left sternal border
    - V3- Directly between V2 and V4
    - V4- 5th intercostal space at midclavicular line
    - V5- Level with V4 at left anterior axillary line
    - V6- Level with V5 at left mid-axillary line
4. Instruct patient to remain still
5. Press the appropriate button to acquire the 12-Lead ECG within 5 minutes of patient contact

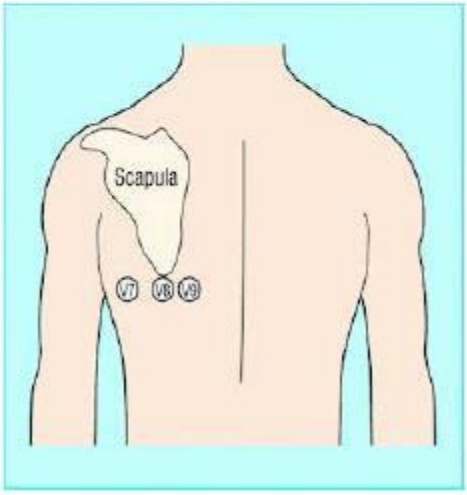
PROCEDURE FOR RIGHT-SIDED 12 LEAD

For Right-sided 12-Lead ECG (V4R) & Posterior 12-Lead ECG (V8 & V9), both together constitutes a 15-Lead ECG:

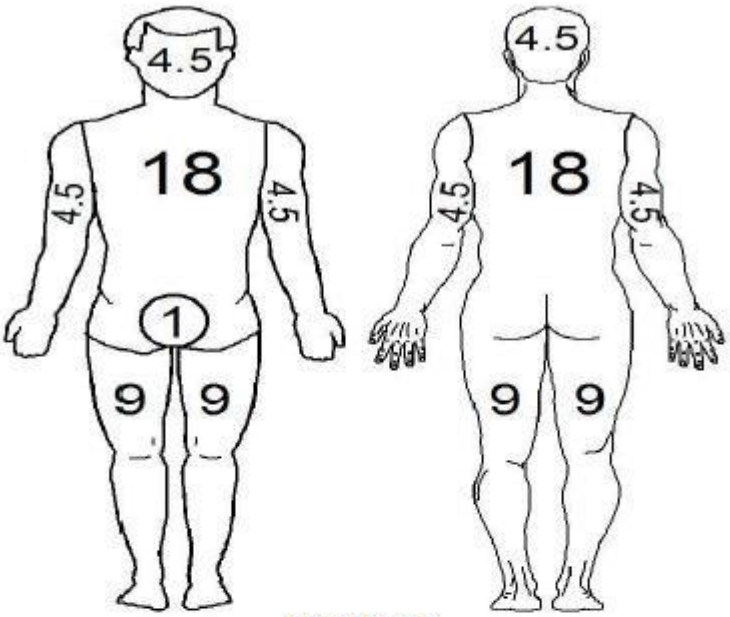
- V4R- (formerly V4) 5th intercostal space at midclavicular line on the patient's right side
- V8 - (formerly V5) 6th intercostal space left posterior at midscapular line
- V9 - (formerly V6) 6th intercostal space left at perispinal line
- Label the second 12-Lead ECG to reflect the new leads: V4 as V4R, V5 as V8, and V6 as V9

1. Print data as per guidelines and place the name and age of the patient on the paper copy of the 12-Lead ECG
2. STEMI suspected: notify and/or transmit to the closest Percutaneous Coronary Intervention (PCI) Center within 5 minutes
3. Document the procedure, time, and results on/with the patient care report (PCR)

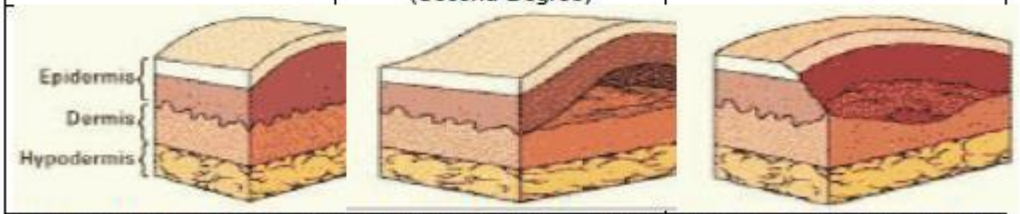




Adult Burn Chart/Reference



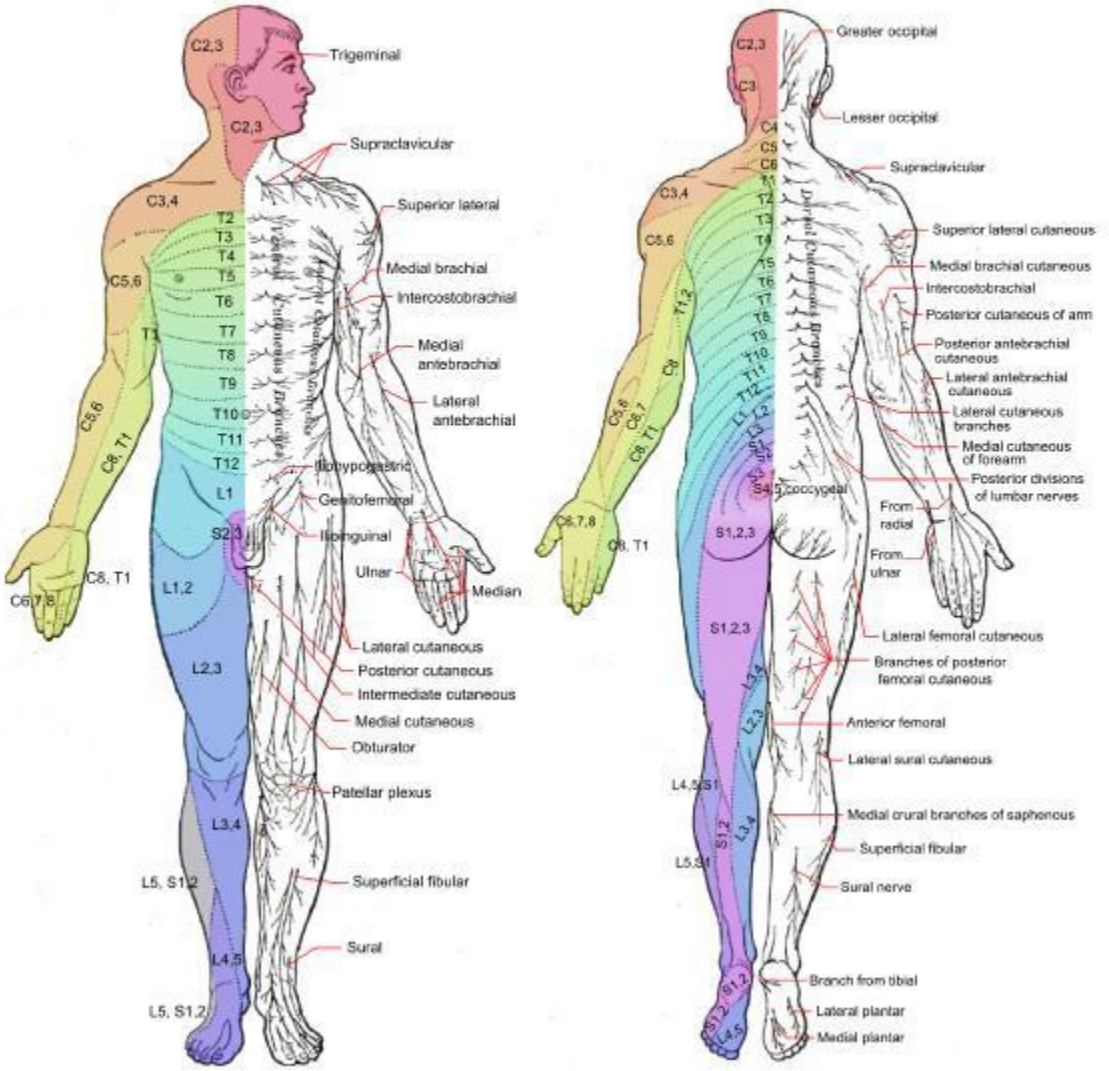
Palm Method:
The palm method is a tool whereby the size of the patients palm is used as an indicator for specific percentage of TBSA.
The surface area of a patients palm equals approximately 1% of TBSA.
This method is particularly useful where the burn has an irregular shape or has a scattered distribution.

Superficial (First-Degree)	Partial Thickness (Second-Degree)	Full Thickness (Third-Degree)
		
Damage to the outer layer of skin {epidermis}, causing pain, redness and swelling.	Damage to both outer skin and underlying tissue layers {epidermis and dermis} causing pain, redness, swelling and blistering.	Damage extends deeper into tissues {epidermis, dermis and hypodermis} causing extensive tissue destruction. The skin may feel numb.

NERVE CHARTS

Dermatomes and Cutaneous Nerves

Schematic demarcation of dermatomes
There is considerable overlap between any two adjacent dermatomes



Drug	Dose (~80 kg)	per/kg	Duration	Description	Adverse Reactions
ketamine RSI	150mg	2mg/kg	15-30 min	Sleep dose for RSI	Hallucinations, ↑secretions
ketamine analgesia	20mg	0.1mg/kg	15-30 min	Analgesia	Hallucinations, ↑secretions
midazolam	5mg	0.05mg/kg	30 min	Sedation 5 mg, anxiety 2mg, sezures 5 mg (up to 10)	Airway obstruction, hypoventilation
diazepam	5-10mg	0.1mg/kg	60 min	Sedation 5mg, anxiety 2mg, antiepileptic 5 mg (up to 10)	Airway obstruction, hypoventilation
etomidate RSI	25mg	0.4mg/kg	15 min	Sleep dose for RSI	Apnea, maintains BP
propofol RSI	200mg	3mg/kg	15 min	Sleep dose for RSI	Apnea, hypotension
morphine	10mg	0.1mg/kg	60 min	Analgesia	Hypoventilation, apnea
fentanyl	50mcg	1mcg/kg	20 min	Analgesia	Hypoventilation, apnea
succinylcholine RSI	150mg	2mg/kg	10 min	Short acting paralytic	Apnea, hyperK$^+$, rhabdomyolysis
rocuronium	100mg	1mg/kg	30 min	Intermediate acting paralytic	Apnea
vecuronium	10mg	0.1mg/kg	45 min	Intermediate acting paralytic	Apnea
atropine	0.4mg	0.01mg/kg	30min	Treats bradycardia	Tachycardia, dilated pupils
naloxone	0.4mg	0.01mg//kg	20 min	Narcotic reversal	Increased pain
flumazenil	0.2mg	0.01mg/kg	20 min	Benzodiazepine reversal	Agitation
dexamethasone	4mg	0.1mg/kg	6 hours	Anaphylaxis, HACE, severe AMS	Hyperglycemia
mannitol	50Grams	1G/kg	4 hours	Extrication for crush injury	Dehydration
ondansetron	4mg	0.1mg/kg	4 hours	Antiemetic	Caution with long QT (torsades)
diphenhydramine	50mg	1mg/kg	4 hours	Antihistamine	Sedation (Benadryl)
promethazine	50mg	1mg/kg	6 hours	Antihistamine, antiemetic	Sedation (Phenergan)
dopamine	1 to 10 mcg/kg/min	----------	Infusion	↑cardiac contractility	Hypertension, ↑HR
dobutamine	2 to 20 mcg/kg/min	----------	Infusion	↑cardiac contractility	Hypertension, ↑HR
phenylephrine	0.15-0.75mcg/kg/min	----------	Infusion	↑systemic vascular resistance	Hypertension, renal failure
norepinephrine	0.05-0.5 mcg/kg/min	----------	Infusion	↑systemic vascular resistance	Hypertension, renal failure
vasopressin	0.01-0.035 **u**/kg/**HR**	----------	Infusion	↑SVR & renal blood flow	Hypertension
epinephrine 1:1,000	0.5mg(0.5ml) **SQ**	0.01mg/kg	1 hour	Tx anaphylaxis, bronchospasm	Skin necrosis in distal areas
Sed/hypnotic	Analgesic	Paralytic	Anticholinergics	Misc.	Pressors

Critical Care Quick Resource Sheet

Thoroughly mix the bag by inverting it twice. Inspect for any leaks or particulate.

Epinephrine Drip

To prepare an epinephrine drip solution:
Add 1 mg of Epinephrine to a 250mL bag of Normal Saline (NS)
1 mg of Epinephrine is:
1mL of Epinephrine 1:1000 or 10mL of Epinephrine 1:10,000

For 4 mcg/mL

	2 mcg/ min	3 mcg/ min	4 mcg/ min	5 mcg/ min	6 mcg/ min	7 mcg/ min	8 mcg/ min	9 mcg/ min	10 mcg/ min
Epinephrine Dose	These are all drops per minute utilizing a mini-drip set (60 drop set)								
Drops per 60 seconds	30	45	60	75	90	105	120	135	150
Drops per 15 seconds	8	11	15	19	23	26	30	34	38

Levophed (Norepinephrine) to Treat Post-Arrest Hypotension Chart
Add 4 mg of Levophed (Norepinephrine) to 250 ml Normal Saline
These are all drops per minute utilizing a mini-drip set (60 drop set)

Dosage using estimated body weight	gtts by Time	0.1 mcg/kg/ min	0.2 mcg/kg/ min	0.3 mcg/kg/ min	0.4 mcg/kg/ min	0.5 mcg/kg/ min
Small Adult (100 lbs/ 45Kg)	1 minute	17 gtts	34 gtts	51 gtts	68 gtts	85 gtts
	15 seconds	4 gtts	9 gtts	13 gtts	17 gtts	21 gtts
Medium Adult (150 lbs/ 68Kg)	1 minute	26 gtts	51 gtts	77 gtts	102 gtts	128 gtts
	15 seconds	7 gtts	13 gtts	19 gtts	26 gtts	32 gtts
Large Adult (200 lbs/ 91Kg)	1 minute	34 gtts	68 gtts	102 gtts	136 gtts	170 gtts
	15 seconds	9 gtts	17 gtts	26 gtts	34 gtts	43 gtts
Extra-Large Adult (250 lbs/ 113 Kg)	1 minute	43 gtts	85 gtts	128 gtts	170 gtts	213 gtts
	15 seconds	11 gtts	21 gtts	32 gtts	43 gtts	53 gtts
Obese Adult (>300 lbs/ 136 Kg)	1 minute	51 gtts	102 gtts	153 gtts	204 gtts	255 gtts
	15 seconds	13 gtts	26 gtts	38 gtts	51 gtts	64 gtts

The infusion should be titrated to achieve a systolic blood pressure between 90-100 mmHg.

$EtCO_2$ Quick Reference

Capnography

INDICATIONS

- Altered mental status
- Cardiac arrest with return of spontaneous circulation (ROSC)
- Any serious trauma or medical condition
- Any use of Naloxone (Narcan)

CONTRAINDICATIONS

None

PROCEDURE

Follow manufacturer's instructions for placement and use of device.
Use on both adult and pediatric patients.
Endotracheal tube (ETT)/blind insertion airway device (BIAD)/bag valve mask (BVM): • Turn on recording instrumentation. • Place $ETCO_2$ sampling device in between ventilation device (BVM/ventilator) and the mask/endotracheal tube (ETT)/King Airway/Combitube/ Laryngeal Mask Airway (LMA) • Attach sampling device to recording instrumentation and ventilate. • The Capnometer shall remain in place with the airway and be monitored throughout
Non-intubated spontaneously breathing patient: • Turn on recording instrumentation. • Place the sampling nasal cannula on the patient. • Attach sampling device to recording instrumentation. Observe and record results. • The capnometer shall remain in place with the airway and be monitored throughout prehospital care and transport.
Continuous positive airway pressure (CPAP)/ Bilevel positive airway pressure (BiPAP): • Follow manufacturer's recommendations for placement of $ETCO_2$ in conjunction with use of CPAP/BIPAP. • Place sampling nasal cannula on the patient. • Place CPAP/ BiPAP mask on patient ensuring a good seal. • Observe and record results. • The capnometer shall remain in place with the airway and be monitored throughout prehospital care and transport.

PEARLS

Normal range → $ETCO_2$ in adult and pediatric patients is 35-45 mm Hg. Cardiac arrest → Attempt to keep $ETCO_2$ above 10 mm Hg.

Post-cardiac arrest → Attempt to keep $ETCO_2$ between 34-40 mm Hg.

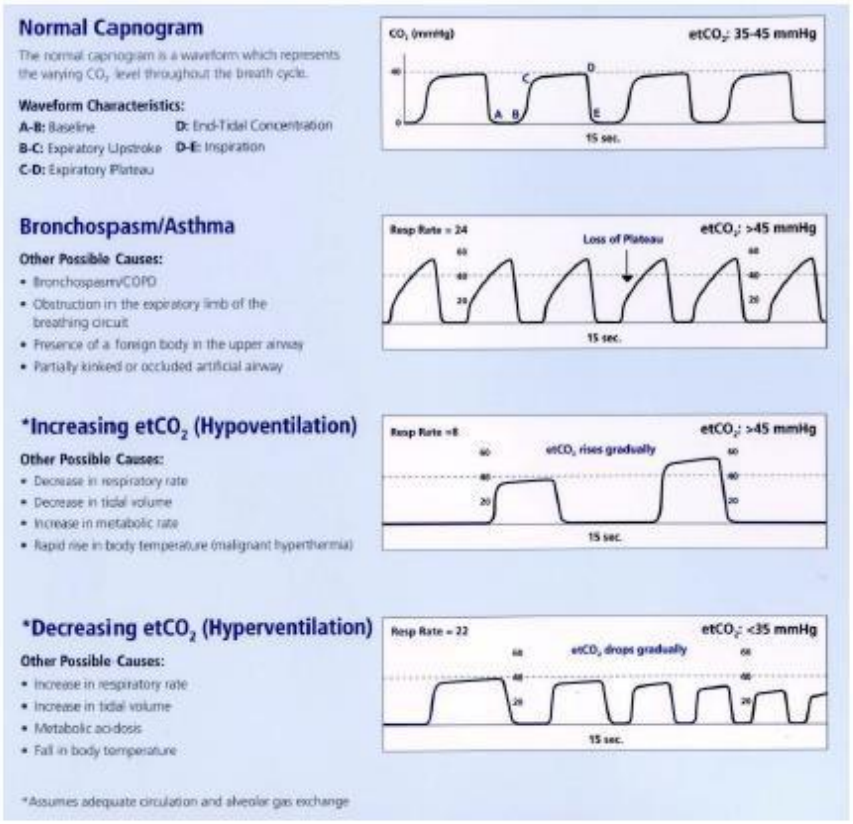
$EtCO_2$ Quick Reference

If $ETCO_2$ levels remain above 45 mm Hg despite ventilatory assistance, bronchodilators, CPAP or BIPAP, intubation may be needed.

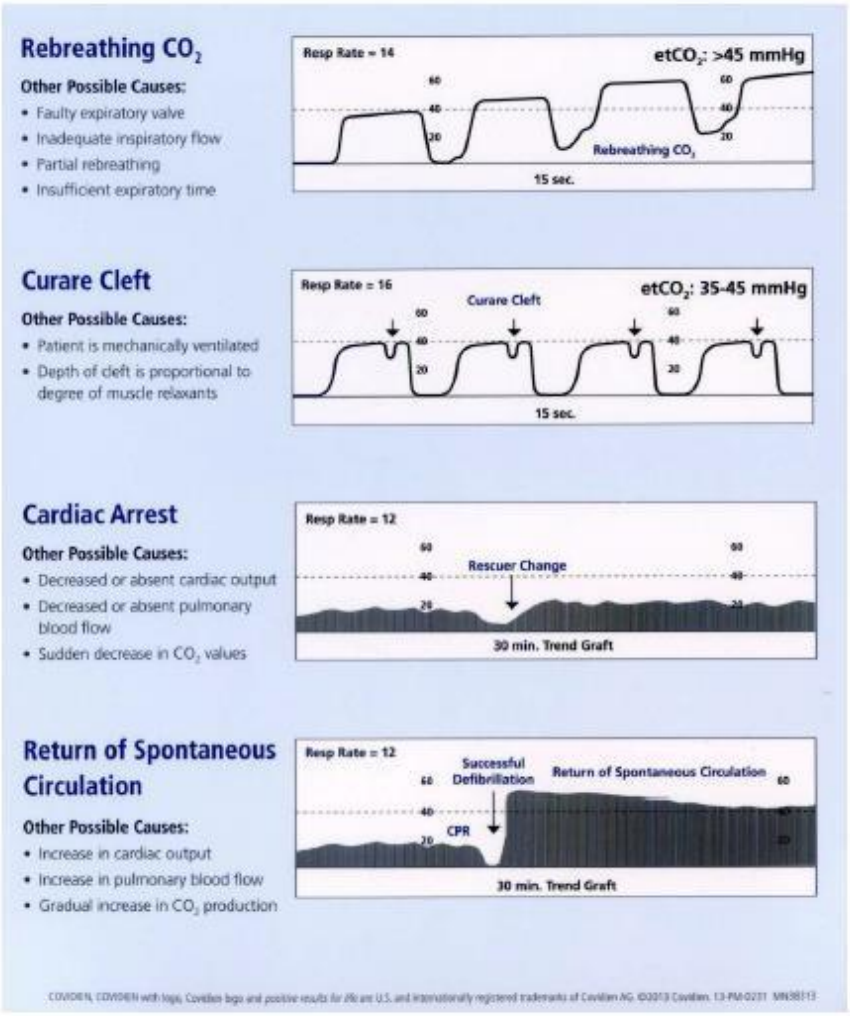
When $ETCO_2$ is not detected, three factors must be addressed:

- Loss of airway/apnea → Esophageal ETT placement or migration
- Circulatory collapse → Cardiac arrest, pulmonary embolism, hypoperfusion
- Equipment failure → Disconnected BVM or ventilator, obstruction in $ETCO_2$ detector or sampling tube

Normal and Abnormal $etCO_2$/Capnograph Waveforms


Normal Capnogram
The normal capnogram is a waveform which represents the varying CO_2 level throughout the breath cycle.
Waveform Characteristics:
A-B: Baseline
B-C: Expiratory Upstroke
C-D: Expiratory Plateau
D: End-Tidal Concentration
D-E: Inspiration
CO_2 (mmHg)
$etCO_2$: 35-45 mmHg
A B C D E
15 sec.
Bronchospasm/Asthma
Other Possible Causes:
• Bronchospasm/COPD
• Obstruction in the expiratory limb of the breathing circuit
• Presence of a foreign body in the upper airway
• Partially kinked or occluded artificial airway
Resp Rate = 24
Loss of Plateau
$etCO_2$: >45 mmHg
15 sec.
*Increasing $etCO_2$ (Hypoventilation)
Other Possible Causes:
• Decrease in respiratory rate
• Decrease in tidal volume
• Increase in metabolic rate
• Rapid rise in body temperature (malignant hyperthermia)
Resp Rate =8
$etCO_2$ rises gradually
$etCO_2$: >45 mmHg
15 sec.
*Decreasing $etCO_2$ (Hyperventilation)
Other Possible Causes:
• Increase in respiratory rate
• Increase in tidal volume
• Metabolic acidosis
• Fall in body temperature
Resp Rate = 22
$etCO_2$ drops gradually
$etCO_2$: <35 mmHg
15 sec.
*Assumes adequate circulation and alveolar gas exchange

$EtCO_2$ Quick Reference



Useful Mnemonics

Causes of Coma/Decreased Level of Consciousness
A - Alcohol (and other drugs), Acidosis (hyperglycemic coma/DKA)
E - Electrolyte abnormality, Endocrine problem, Epilepsy
I - Insulin (diabetes/hypoglycemic shock)
O - Oxygen (Hypoxia), Overdose (or poisoning)
U - Uremia (renal failure/insufficiency)
T - Trauma; Temperature (hypothermia, heat stroke)
I - Infection (e.g., meningitis, encephalitis, sepsis)
P - Psychogenic ("hysterical coma")
S - Stroke or Space-occupying lesions in the cranium; Seizure; Shock

Coma Assessment
D - Depth of coma (responds to verbal or painful stimulus, unresponsive)
E - Eyes (PERRLA)
R - Respiration (rate and rhythm)
M - Motor (posturing; loss of movement/sensation)

Level of Consciousness
A - Alert
V - Responds to Verbal stimuli
P - Responds to Painful stimuli
U – Unresponsive

Patient History / Pain Assessment
A - Allergies
M - Medications
P - Past medical history (illness, injury)
P - Pain (PPQRST)
L - Last intake (food, fluid)
E - Ever happen before?
P - Pain (sharp or dull)
P - Palliative &/or Precipitating (exacerbating) measures related to the pain
Q - Quality (diffuse, pinpoint, or localized)
R - Radiating
S - Severity (scale of 1-10)
T - Timing: Time of onset; frequency; duration

Pupil Reaction
P - Pupils
E - Equal
R - Round
R - Reactive to
L - Light

Dive Related Accidents
V - Visual (Tunnel vision or blurred vision)
E - Ear symptoms (Tinnitus)
N - Nausea and/or vomiting
T - Twitching (Generally involves facial muscles, but can involve arms/legs)
L - Irritability (Change in diver's mental status)
D - Disability (Sudden neurological deficit)

Patient Care
V - Vitals
O – Oxygen
M – Monitor / Medications
I – IV/IO
T - Transport

XII. MEDICATIONS AND THEIR USES

Trade names start with an uppercase letter and appear in **blue**.
Generic names start with a lowercase letter and appear in **red**.
The primary type of medical problem for which the medication is used is listed, and the type of medication is shown in parentheses, when indicated.

Abilify Bipolar disorder, schizophrenia
Accolate Asthma
Accupril High blood pressure, congestive heart failure
acetaminophen with codeine Pain
Aciphex Gastric problems (antiulcer)
Actiq Pain (narcotic analgesic)
Actonel Osteoporosis
Actos Diabetes (oral antidiabetic)
acyclovir Viral infections (antiviral)
Adderall Attention deficit/hyperactivity disorder
Adipex Weight loss
Advair Breathing problems
albuterol Breathing problems (bronchodilator)
Aldactazide High blood pressure (diuretic/water pill)
Aldactone Congestive heart failure (diuretic/water pill)
Aldomet High blood pressure
alendronate Osteoporosis
Alesse 28 Birth control pills
Allegra Allergies (antihistamine)
Alli Weight loss
allopurinol Gout, kidney stones
alprazolam Anxiety, depression (sedative/antianxiety)
Altace High blood pressure (ACE inhibitor)
Alupent Asthma, breathing problems (bronchodilator)
Amaryl Diabetes (oral antidiabetic)
Ambien Insomnia (hypnotic)
Amitiza Gastrointestinal problems
amitriptyline Depression (antidepressant)
amlodipine High blood pressure, angina
amoxicillin Infection (antibiotic)
Amoxil Infection (antibiotic)
Anaprox Arthritis (anti-inflammatory)
Ansaid Arthritis (anti-inflammatory)
Antivert Dizziness, motion sickness (antivertigo)
Apresoline High blood pressure (antihypertensive)
Aricept Alzheimer's disease
Artane Parkinson's disease (anti-Parkinson)
Arthrotec Arthritis (anti-inflammatory)
Asacol Ulcerative colitis (antibacterial)
Asmanex Asthma (anti-inflammatory)
Aspirin Analgesic
Atarax Anxiety, behavioral disorders (sedative)
atenolol High blood pressure, heart problems, angina (beta blocker)
Ativan Anxiety (sedative/antianxiety)
Atrovent Breathing problems (bronchodilator)

Augmentin Infection (antibiotic)

Avandamet Diabetes
Avandia Diabetes (oral antidiabetic)
Avapro High blood pressure
Avodart Prostate enlargement
Axid Ulcers (antiulcer)
azithromycin Infection (antibiotic)
Azulfidine Ulcerative colitis (antibacterial)
Bactrim Infection (antibiotic)
Bactroban Impetigo (antibiotic)
Benadryl Allergies (antihistamine)
benazepril High blood pressure, congestive heart failure
Benicar High blood pressure
Bentyl Irritable bowel syndrome (anticholinergic)
benzonatate Cough (antitussive)
Biaxin Infection (antibiotic)
bisoprolol High blood pressure (diuretic)
Boniva Osteoporosis
Brethine Asthma, breathing problems (bronchodilator)
Bumex Edema, congestive heart failure (diuretic)
bupropion Depression, smoking cessation
BuSpar Anxiety (antianxiety)
buspirone Anxiety (antianxiety)
Byetta Diabetes
Caduet High blood pressure
Calan Angina, high blood pressure, rapid heart rate
Capoten High blood pressure, congestive heart failure
captopril High blood pressure, congestive heart failure
Carafate Ulcers (antiulcer)
carbamazepine Seizure disorder (anticonvulsant)
Cardizem Heart problems, angina (coronary vasodilator)
Cardura High blood pressure (alpha blocker)
carisoprodol Muscle spasms (muscle relaxant)
Cartia Angina, heart problems (calcium-channel blocker)
carvedilol High blood pressure
Catapres High blood pressure (antihypertensive)
Ceclor Infection (antibiotic)
cefaclor Infection (antibiotic)
cefdinir Infection (antibiotic)
cefixime Infection (antibiotic)
cefprozil Infection (antibiotic)
Ceftin Infection (antibiotic)
cefuroxime Infection (antibiotic)
Cefzil Infection (antibiotic)
Celebrex Arthritis (anti-inflammatory)
Celexa Depression (antidepressant)
cephalexin Infection (antibiotic)
cetirizine Antihistamine
Chantix Smoking cessation
Cialis Male impotence
Ciloxin Infection (antibiotic)
cimetidine Ulcers, gastric problems (antiulcer)

Cipro Infection (antibiotic)
citalopram Depression

Clarinex Allergies (antihistamine)
Claritin Allergies (antihistamine)
clarithromycin Infection (antibiotic)
clindamycin Infection (antibiotic)
Clinoril Arthritis pain (anti-inflammatory)
clonazepam Seizure disorder (anticonvulsant)
clonidine High blood pressure (antihypertensive)
clopidogrel Antiplatelet
clotrimazole Fungal infection (antifungal)
Colestid High cholesterol (cholesterol-lowering agent)
Combivent Breathing problems (bronchodilator)
Compazine Nausea (antiemetic)
Concerta Attention deficit/hyperactivity disorder
Coreg High blood pressure, heart problems
Corgard Heart problems, angina (beta blocker)
Cotrim Infection (anti-infective)
Coumadin Blood clots (blood thinner)
Cozaar High blood pressure
Crestor High cholesterol
cyclobenzaprine Muscle spasms (muscle relaxant)
Cymbalta Depression
Darvocet-N Pain management (narcotic analgesic)
Daypro Arthritis (anti-inflammatory)
Deltasone Severe inflammation (anti-inflammatory)
Demadex Edema, congestive heart failure (diuretic)
Demerol Pain (narcotic analgesic)
Depakote Seizure disorder (anticonvulsant)
Desyrel Depression (antidepressant)
Detrol Overactive bladder
Dexedrine Narcolepsy, attention-deficit disorder
dexmethylphenidate Attention deficit/hyperactivity disorder
DiaBeta Diabetes (oral antidiabetic)
Diabinese Diabetes (oral antidiabetic)
diazepam Anxiety (antianxiety)
diclofenac Inflammation (anti-inflammatory)
Diflucan Fungal infection (antifungal)
Digitek Heart problems
digoxin Heart problems
Dilantin Seizure disorder (anticonvulsant)
diltiazem Heart problems, angina (coronary vasodilator)
Diovan High blood pressure (antihypertensive)
Dipentum Ulcerative colitis
diphenhydramine Allergies (antihistamine)
dipyridamole Thromboembolism
Ditropan Bladder problems (antispasmodic)
Donnatal Irritable bowel syndrome (anticholinergic)
doxazosin Hypertension, prostate problems
doxycycline Infection (antibiotic)
Duricef Infection (antibiotic)
Dyazide High blood pressure, edema (diuretic)

DynaCirc High blood pressure
E.E.S. Infection (antibiotic)
Effexor Depression (antidepressant)
Elavil Depression (antidepressant)
Eldepryl Parkinson's disease (anti-Parkinson)
Elocon Dermatologic problems
Emend Nausea (antiemetic)
enalapril High blood pressure, heart failure
Enbrel Rheumatoid arthritis
E-Mycin Infection (antibiotic)
Entex Cough and congestion (expectorant)
epinephrine Cardiac arrest, allergic reactions
Epivir Antiretroviral
Ery-Tab Infection (antibiotic)
erythromycin Infection (antibiotic)
escitalopram Depression
Esidrix High blood pressure (diuretic/water pill)
Eskalith Behavioral disorders (antimanic)
Estrace Estrogen therapy
Estraderm Estrogen therapy
estradiol Menopause, gynecologic problems
etodolac Arthritis, pain (anti-inflammatory)
Evista Osteoporosis
famotidine Ulcers, gastric problems (antiulcer)
Feldene Arthritis (anti-inflammatory)
fentanyl Pain management (narcotic analgesic)
finasteride Prostate enlargement
Fiorinal Pain management (non-narcotic analgesic)
Flagyl Infections (antibacterial)
Flexeril Muscle spasms (muscle relaxant)
flexofenadine Antihistamine
Flomax Enlarged prostate (alpha blocker)
Flonase Allergies
Flovent Breathing problems
Floxin Infection (antibiotic)
fluconazole Fungal infection
fluoxetine Depression (antidepressant)
flurbiprofen Inflammation (anti-inflammatory)
folic acid Anemia
Fosamax Osteoporosis
fosinopril Osteoporosis
furosemide Congestive heart failure (diuretic/water pill)
gabapentin Seizures
Gabitril Seizure disorder (antiseizure)
Gantrisin Infection (antibiotic)
gemfibrozil High cholesterol (cholesterol-lowering agent)
Geodon Antipsychotic
glimepiride Diabetes (hyperglycemia)
glipizide Diabetes (oral antidiabetic)
Glucophage Diabetes (oral antidiabetic)
Glucotrol Diabetes (oral antidiabetic)
Glucovance Diabetes (oral antidiabetic)
glyburide Diabetes (oral hypoglycemic)

Glycolax Constipation
granisetron Nausea
guaifenesin Cough and congestion (expectorant)
Halcion Insomnia (hypnotic/sedative)
Haldol Psychotic disorders (antipsychotic)
HCTZ High blood pressure (diuretic/water pill)
Humira Rheumatoid arthritis
Humulin Diabetes (insulin)
hydrochlorothiazide High blood pressure (diuretic)
hydrocodone Cough, pain (narcotic)
HydroDiuril High blood pressure (diuretic/water pill)
hydroxyzine Anxiety, behavioral disorders (sedative)
Hygroton High blood pressure (diuretic/water pill)
Hytrin High blood pressure (alpha blocker)
Hyzaar High blood pressure (antihypertensive)
ibuprofen Inflammation, pain, fever (anti-inflammatory)
Imdur Heart problems, angina (coronary vasodilator)
Imitrex Migraine headaches (antimigraine)
Inderal High blood pressure, heart problems, angina (beta blocker)
Indocin Osteoarthritis, pain (anti-inflammatory)
indomethacin Arthritis (anti-inflammatory)
Intal Asthma (mast cell stabilizer)
Iophen Cough (antitussive)
Isoptin Angina, high blood pressure, rapid heart rate
Isordil Heart problems, angina (coronary vasodilator)
isosorbide dinitrate Heart problems, angina (coronary vasodilator)
K-Dur Potassium replacement, taken with diuretics
K-Tab Potassium replacement, taken with diuretics
Keflex Infection (antibiotic)
Keppra Seizure disorder (anticonvulsant)
ketoconazole Fungal infection (antifungal)
ketorolac Pain management (anti-inflammatory)
Klonopin Seizure disorder (anticonvulsant)
labetalol High blood pressure (beta blocker)
Lamictal Seizure disorder (anti-epileptic)
Lamisil Antifungal
Lanoxin Heart problems
Lasix Congestive heart failure (diuretic/water pill)
Lescol High cholesterol (cholesterol-lowering agent)
Levaquin Infection (antibiotic)
Levitra Male impotence
Levothroid Thyroid disease (thyroid hormone)
levothyroxine Thyroid problems (thyroid hormone)
Levoxyl Thyroid disease (thyroid hormone)
Lexapro Depression
Librax Peptic ulcer (anticholinergic)
Lipitor High cholesterol (cholesterol-lowering agent)
lisinopril High blood pressure
lithium carbonate Behavioral disorders (antipsychotic)
Lodine Arthritis, pain (anti-inflammatory)
Loestrin Fe Birth control pills
Lomotil Diarrhea (antidiarrheal)
Lopid High cholesterol (cholesterol-lowering agent)

Lopressor High blood pressure (beta blocker)
Lorabid Infection (antibiotic)
loracarbef Infection (antibiotic)
loratadine Allergies (antihistamine)
lorazepam Anxiety (sedative/antianxiety)
Lorcet Pain (narcotic analgesic)
Lortab Pain (narcotic analgesic)
Lotensin High blood pressure (ACE inhibitor)
Lotrel Hypertension
Lotrimin Fungal infection (antifungal cream and ointment)
Lotrisone Fungal infection (antifungal cream)
lovastatin High cholesterol (cholesterol-lowering agent)
Lozol Congestive heart failure, high blood pressure
Lunesta Sleep aid
Luvox Parkinson's disease (anti-Parkinson)
Lyrica Nerve pain
Macrobid Urinary tract infection (antibiotic)
Macrodantin Urinary tract infection (antibiotic)
marijuana Comfort management
Maxzide High blood pressure (diuretic/water pill)
meclizine Dizziness, vertigo, motion sickness (antiemetic)
medroxyprogesterone Gynecologic problems
meloxicam Inflammation, pain
metformin Diabetes
methadone Pain (narcotic analgesic), opiate withdrawal
methylphenidate Attention deficit disorder, narcolepsy
methylprednisolone Anti-inflammatory
metoclopromide Gastric problems (antiemetic)
metoprolol tartrate High blood pressure, heart problems (beta blocker)
metronidazole Infection (anti-infective)
Mevacor High cholesterol (cholesterol-lowering agent)
Micro-K Potassium replacement, taken with diuretics
Micronase Diabetes (oral antidiabetic)
Minipress High blood pressure (antihypertensive)
Minocin Infection (antibiotic)
minocycline Infection (antibiotic)
Miralax Constipation
Mirapex Parkinson's disease (anti-Parkinson)
Mircette Birth control pills
mirtazapine Anxiety, depression
Mobic Inflammation, pain
moexipril High blood pressure
Monopril High blood pressure
morphine Pain management (narcotic analgesic)
Motrin Inflammation, pain, fever (anti-inflammatory)
nabumetone Inflammation, pain (anti-inflammatory)
Namenda Alzheimer's disease
Naprosyn Inflammation, pain (anti-inflammatory)
naproxen Inflammation, pain (anti-inflammatory)
Nasacort Asthma, breathing problems (anti-inflammatory)
Nasonex Allergies (anti-inflammatory)
Necon Birth control pills
Neurontin Seizure disorders (anticonvulsant)

Nexium Gastric problems
Niaspan High cholesterol
nifedipine Heart problems, angina (coronary vasodilator)
Nitro-Dur Heart problems, angina (coronary vasodilator)
nitrofurantoin Urinary tract infection
nitroglycerin Heart problems, angina (coronary vasodilator)
Nitrostat Heart problems, angina (coronary vasodilator)
nizatidine Ulcers (antiulcer)
Nizoral Fungal infection (antifungal)
Norco Pain (narcotic analgesic)
Normodyne High blood pressure
nortriptyline Depression (antidepressant)
Norvasc High blood pressure (calcium-channel blocker)
nystatin Fungal infection (antifungal)
omeprazole Ulcers, gastric problems (antiulcer)
Omnicef Infections (antibiotic)
Omnipen Infections (antibiotic)
ondansetron Nausea
Ortho-Cept Birth control pills
Ortho-Cyclen Birth control pills
Ortho-Novum Birth control pills
Ortho Tri-Cyclen Birth control pills
Oruvail Arthritis pain (anti-inflammatory)
oseltamivir Antiviral
oxaprozin Inflammation, pain, fever (anti-inflammatory)
oxcarbazepine Seizures
oxybutynin Bladder problems (antispasmodic)
oxycodone Pain (narcotic analgesic)
Oxy-Contin Pain (narcotic analgesic)
Pamelor Depression (antidepressant)
pantoprazole Gastric problems, ulcers
paroxetine Depression (antidepressant)
Pataday Allergies (antihistamine)
Patanol Allergies (antihistamine)
Paxil Depression (antidepressant)
Pediazole Infection (antibiotic)
penicillin Infection (antibiotic)
pentoxifylline Vascular disease (blood thinner)
Pepcid Ulcers, gastric problems (antiulcer)
Percocet Pain (narcotic analgesic)
Percodan Pain (narcotic analgesic)
Persantine Thromboembolism
phenazopyridine Urinary tract irritation, infection
Phenergan Nausea (antiemetic)
phenobarbital Seizure disorder (anticonvulsant)
phentermine Weight loss
phenytoin Seizure disorder (anticonvulsant)
Plavix Thromboembolism (antiplatelet)
Plendil High blood pressure (calcium-channel blocker)
potassium chloride Potassium replacement, taken with diuretics
Prandin Diabetes (oral antidiabetic)
Pravachol High cholesterol (cholesterol-lowering agent)
prednisone Severe inflammation (anti-inflammatory)

Premarin Menopause, gynecologic problems (estrogen)
Prempro Menopause, gynecological problems
Prevacid Ulcers, gastric problems (antiulcer)
Prilosec Ulcers, gastric problems (antiulcer)
Prinivil High blood pressure (ACE inhibitor)
Pro-Banthine Peptic ulcer (anticholinergic)
Procan Rapid heart rate, tachycardia (antiarrhythmic)
Procardia Heart problems, angina (coronary vasodilator)
Proloprim Infection, mainly urinary tract (antibiotic)
promethazine Nausea (antiemetic)
Propacet Pain management (narcotic analgesic)
Propecia Hair loss
propoxyphene Pain management (narcotic analgesic)
propranolol High blood pressure, heart problems, angina (beta blocker)
Proscar Prostate enlargement
Protonix Gastric problems
Proventil Breathing problems (bronchodilator)
Provera Gynecologic problems (progestogen)
Provigil Narcolepsy
Prozac Depression (antidepressant)
Pulmicort Asthma
Pyridium Urinary tract infections, pain
Quinaglute Ventricular arrhythmias (antiarrhythmic)
quinapril High blood pressure (ACE inhibitor)
Qvar Asthma, breathing problems (anti-inflammatory)
ramipril High blood pressure (ACE inhibitor)
ranitidine Ulcers, gastric problems (antiulcer)
Reglan Nausea (antiemetic)
Relafen Inflammation, pain (anti-inflammatory)
Remeron Anxiety, depression (sedative)
Restoril Sleep disorders (hypnotic)
Retrovir Antiretroviral
Risperdal Psychological disorders (antipsychotic)
Ritalin Attention deficit disorder, narcolepsy
Robaxin Muscle spasms (muscle relaxant)
Roxicet Pain management (narcotic analgesic)
Rythmol Heart problems, ventricular tachycardia
Sectral High blood pressure (beta blocker)
Septra Infection (antibiotic)
Serevent Asthma, breathing problems (bronchodilators)
Seroquel Psychological disorders (antipsychotic)
sertraline Depression (antidepressant)
Serzone Depression (antidepressant)
simvastatin High cholesterol
Sinemet Parkinson's disease (anti-Parkinson)
Sinequan Anxiety, depression (antidepressant)
Singulair Asthma
Skelaxin Muscle relaxant
Slo-Bid Breathing problems, asthma (bronchodilator)
Slow-K Potassium replacement, taken with diuretics
Soma Muscle spasms (muscle relaxant)
Spiriva Breathing problems
spironolactone High blood pressure, heart failure (diuretic)

Suboxone Treatment of opioid dependence
sucralfate Ulcers (antiulcer)
Sular High blood pressure
sulfamethoxazole Infection (antibiotic)
sulfasalazine Ulcerative colitis (antibacterial)
sulfisoxazole Infection (antibiotic)
Sumycin Infection (antibiotic)
Suprax Infection (antibiotic)
Sustiva Antiretroviral
Symbicort Asthma
Synthroid Thyroid disease (thyroid hormone)
Tagamet Ulcers, gastric problems (antiulcer)
Tamiflu Antiviral
tamoxifen Cancer (antineoplastic)
Tavist Allergies (antihistamine)
TegretoI Seizure disorder (anticonvulsant)
temazepam Insomnia (sedative)
Tenex High blood pressure (alpha blocker)
Tenormin High blood pressure, heart problems, angina (beta blocker)
Tequin Infection (anti-infective)
terazosin High blood pressure (alpha blocker)
tetracycline Infection (antibiotic)
Theo-Dur Breathing problems (bronchodilator)
theophylline Breathing problems (bronchodilator)
Tiazac High blood pressure
Ticlid Stroke (antiplatelet)
Tigan Nausea and vomiting (antiemetic)
Tofranil Depression (antidepressant)
Tolinase Diabetes (oral antidiabetic)
Topamax Seizures
Toprol High blood pressure (beta blocker)
Toradol Short-term pain
tramadol Pain (analgesic)
trazodone Depression (antidepressant)
Trental Vascular disease (blood thinner)
triamterene High blood pressure (diuretic)
Triavil Anxiety, depression (antidepressant)
Tricor High triglycerides (antilipemic)
trimethoprim Infection, mainly urinary tract (antibiotic)
Trimox Infection (antibiotic)
Triphasil Birth control pill
Trivora-28 Birth control pills
Tussionex Cough (antitussive)
Tylenol with codeine (Tylenol #3) Pain
Ultram Pain (analgesic)
valacyclovir Herpes (antiviral)
Valium Anxiety (antianxiety)
valproic acid Seizure disorder (anticonvulsant)
Valtrex Herpes (antiviral)
Vantin Infections (antibiotic)
Vasotec High blood pressure, heart failure
Veetids Infection (antibiotic)
venlafaxine Depression (antidepressant)

Ventolin Breathing problems (bronchodilator)
verapamil Angina, high blood pressure, rapid heart rate
Viagra Male impotence
Vibramycin Infection (antibiotic)
Vicodin Pain (narcotic)
Vicoprofen Pain (narcotic analgesic)
Viramune Antiretroviral
Viread Antiretroviral
Voltaren Arthritis (anti-inflammatory)
Vytorin High cholesterol
warfarin sodium Blood clots (blood thinner)
Wellbutrin Depression (antidepressant)
Xalatan Glaucoma
Xanax Anxiety, depression (sedative)
Xenical Weight loss
Xopenex Breathing problems
Yasmin Birth control
YAZ Birth control
Zantac Ulcers, gastric problems (antiulcer)
Zerit Antiretroviral
Zestoretic High blood pressure
Zestril High blood pressure (ACE inhibitor)
Zetia High cholesterol
Ziac High blood pressure (beta blocker, diuretic)
Zithromax Infection (antibiotic)
Zocor High cholesterol (cholesterol-lowering agent)
Zofran Nausea
Zoloft Depression (antidepressant)
zolpidem Sleep aid
Zomig Migraine headaches
zonisamide Seizures
Zovirax Herpes, shingles, chicken pox (antiviral)
Zyflo Asthma
Zyloprim Gout
Zyprexa Psychological disorders (antipsychotic)
Zyrtec Allergies (antihistamine)

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NO FURTHER ENTRIES

CRITICAL CARE AIR TRANSPORT CLINICAL PRACTICE GUIDELINE

Negative Pressure Wound Therapy (CPG ID:49)

The goal of this clinical practice guideline (CPG) is to optimize wound management for the traumatically injured with a focus on the aeromedical evacuation (AE) environment. The series is developed by the Center for Sustainment of Trauma and Readiness Skills, University of Cincinnati Medical Center.

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Major updates

1. An algorithm for treating bleeding with a negative pressure wound therapy Negative Pressure Wound Therapy (NPWT) dressing has been included.

2. Appendix A which describes how to replace the KCI suction pump with the Impact suction has been added.

3. Appendix B which describes how to convert the KCI Vacuum Assisted Closure (VAC) Freedom to an instillation NPWT dressing has been developed.

Goal

This CPG provides an overview of negative pressure wound therapy and its uses in the treatment of soft-tissue battle wounds. It describes the technical aspects of troubleshooting negative pressure wound therapy, addresses equipment and dressing failures; and provides an algorithm for how to treat bleeding that may occur during patient evacuation. Throughout the guideline, a focus has been placed on the special conditions associated with en route care.

Background

NPWT promotes wound healing through the application of a vacuum paired with a sealed dressing; the benefits of wound healing seem independent of the type of NPWT system used.[1] The continuous vacuum draws fluid out from the wound[2] and also increases blood flow to the area.[3] Studies could not demonstrate, however, that wound bacterial counts were lowered.[4,5] In general, NPWT decreases wound edema and accelerates the healing process.[6] The vacuum may be applied continuously or intermittently, depending on the type of wound being treated and the clinical objectives. The continuous mode of suction is most commonly used for surgical wounds. Some NPWT devices allow delivery of fluids, such as saline or antibiotics to irrigate the wound; intermittent removal of used fluid supports the cleaning and drainage of the wound bed.[7] In addition, NPWT dressings are well-suited for use for patients with an open abdomen or chest after damage control surgery.[8] For these reasons, NPWT has become the preferred alternative to wet-to-dry dressings and other temporary wound coverage methods, particularly in the aeromedical evacuation (AE) environment. Thus, each Critical Care Air Transport Team (CCATT) member must thoroughly understand the NPWT equipment, how to troubleshoot device and dressing malfunctions, and manage associated complications. The only flight-approved commercial NPWT system is the KCI VAC Freedom. KCI provides a thorough clinical practice guideline for clinicians.[9]

Advantages of NPWT

Negative pressure dressings can be left in place for 24 to 72 hours, depending on wound characteristics. This makes the NPWT dressings generally less labor-intensive to manage and more ideal for AE.

NPWT allows for the accurate measurement of fluid and blood loss from wounds, to include losses associated with temporary abdominal and chest closures after damage control surgery. Understanding wound-related fluid losses is an important part of optimizing post-surgical resuscitation.

Techniques of NPWT

The term "wound VAC" has become synonymous with the KCI negative pressure therapy system. The KCI VAC Freedom is the only commercially approved device certified for use during AE. For that reason the KCI system will be reviewed in detail below, but it is important to understand multiple ways exist to create a negative pressure dressing.

NPWT systems can be fashioned using a standard portable suction device and dressing supplies. For example, NATO and Role 2 facilities often create negative pressure dressings using gauze or surgical towels covered with an occlusive dressing such as Ioban/Tegaderm and surgical drains connected to suction tubing. The open abdomen NPWT dressing, constructed as such, is sometimes referred to as a "Balad Pack" or "VAC Pack".

If a non-KCI device (other than the Impact suction device) is being used in-flight, then a waiver must be obtained for its use. As an alternative, the non-approved suction device can be replaced with the standard CCATT Impact suction device adjusted to a continuous mode of suction.

Components of a NPWT Dressing

There are **six components** to a NPWT system.

(1) Porous material:

- It is usually cut to fit into the wound to conform to its shape. This allows the negative pressure to be distributed evenly throughout wound and facilitates fluid egress.
- Examples of porous materials include (1) Reticulated Open Cell Foam (ROCF) is used in the KCI system and it is the type of material most commonly used; (2) sterile gauze; and (3) sterile surgical towels.

(2) Occlusive dressing:

- The entire wound must be covered and the dressing adherent to the intact surrounding skin; an additional topical adhesive (such as benzoin) can improve the success of creating an airtight seal.
- The materials most often used are either the KCI-branded adhesive dressings or Ioban (particularly for large wounds), however, other adhesive plastic dressings, such as Tegaderm may also be used.
- The skin must be dry for the dressing to stick well and remain occlusive; an airtight seal is required to allow the suction device to maintain negative pressure within the wound.

(3) Suction conduit:

- Tubing transmits the negative pressure from the suction device to the dressing.
- With the KCI system there is a device called the SensaT.R.A.C. Pad that is attached to the end of the tubing. The SensaT.R.A.C pad is placed over an opening created in the underlying dressing. This part of the dressing is also referred to as the "lily pad".

- Other conduits may include non-collapsible chest tubes, suction tubing, and surgical drains (with or without Heimlich valves).

(4) Y-connector:

- Allows a single suction device to be used for multiple small wounds.
- This arrangement may be less effective in maintaining negative pressure if the combined size of the wounds is too large.
- A challenge with y-connected dressings is that a leak in any one of the attached dressings will cause loss of suction in all wounds and result in fluid accumulation within the dressings and wounds themselves.
- Contaminated or infected wounds should not be connected via y-connecter to any other wound.[9]

(5) Fluid collection canisters:

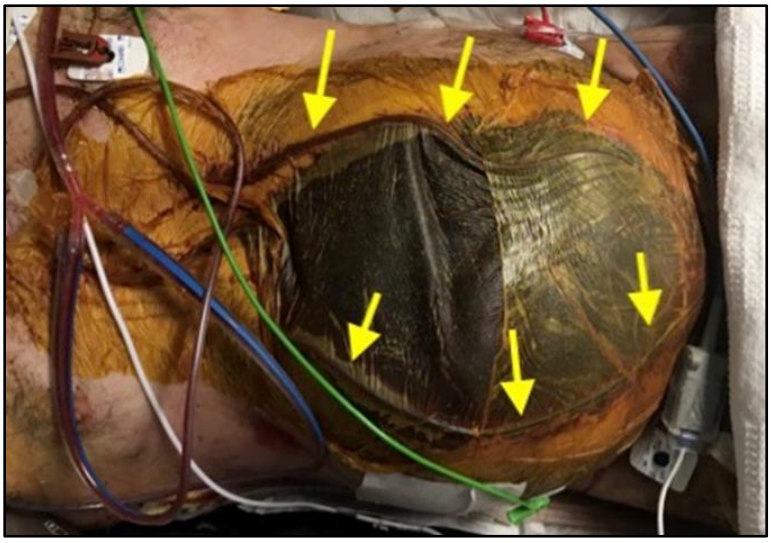
- Canisters collect blood and fluids removed from the wound and facilitate accurate I/Os.
- The VAC Freedom collection canisters are small (300 ml) and contain a gel pack to solidify fluids removed from the wound; these canisters cannot be emptied or reused. Calculate canister requirements carefully before departing on any AE missions.
- Fluid can be collected in standard suction canisters using the Impact suction device. These canisters may be reused if adequate supplies during flight are not available, but this should be avoided.

(6) Suction device:

- The KCI VAC Freedom is the only NPWT device approved for use in AE.
- The Impact suction device can also be used for NPWT. If the Impact suction device is used, ensure settings reflect the original orders for NPWT (i.e. continuous at -125mmHg). See Appendix A.

Figure 1. Temporary abdominal closure

Figure 1 demonstrates a temporary abdominal closure following a trauma laparotomy. A perforated clear plastic sheet was first placed directly on the bowel, followed by blue OR towels (usually a black sponge is used). Two nasogastric tubes (NGTs) were then placed on top of the towels (see arrows), followed by an Ioban seal. Finally, the NGTs were attached to an Impact suction device.



Operation of the KCI NPWT System

Continuous versus Intermittent Settings

Continuous therapy provides a constant level of negative pressure, and intermittent therapy cycles between negative pressure and zero pressure. Most wounds are managed with continuous therapy.

Negative Pressure Settings

The units are set in millimeters of mercury (mmHg) and the surgeon who placed the device will generally set the suction parameters; the majority of wounds will be managed with -125 mmHg of continuous suction. NPWT dressings that cover skin grafts may have lower settings such as -75 mmHg of continuous suction.

Suction Intensity

This determines intensity with which the pump reaches the set negative pressure. The value is set between 0 and 10. NPWT may cause mechanical deformation of the wound edge that can cause increased pain to the patient. Adjusting the suction pressure and intensity can help with the patient's pain, while ensuring therapeutic NPWT goals are still met.

Preflight NPWT Checklist

There are **eight elements** to consider when planning an AE mission with a patient that has a NPWT dressing.

(1) Understand the nature of wound:

- An understanding of the nature of the wound and underlying injury will aid the provider in troubleshooting NPWT dressing issues. This is critical for both soft tissue wounds on the extremities and for NPWT management on the abdomen. For example, patients with a midline abdominal wound VAC may have the abdominal wall (fascia) closed with a wound VAC applied to the skin/soft tissue only (called an "incisional wound VAC"), or the abdominal wall (fascia) may have been left open temporarily with the wound VAC communicating directly with the intra-abdominal contents (called a "temporary abdominal closure," "TAC," or AbThera).
- Failure of an incisional wound VAC (fascia closed) in flight can be remedied by simply switching to wet-to-dry dressings.
- Failure of an open abdominal wound VAC/AbThera in flight will likely lead to evisceration.
- Placing a NPWT dressing directly over a vascular repair is contraindicated. However, if a vascular repair has good soft tissue coverage (i.e. muscle), some surgeons will utilize NPWT to manage large associated soft tissue injuries. It is important to understand whether the wound contains a vascular repair; the location of the repair would be the best place to first apply manual pressure if life-threatening bleeding were to develop (see section, Special Considerations).

(2) Ensure the dressing has an airtight seal:

The NPWT adhesive dressing should have an airtight seal along all wound edges. With suction applied, the dressing should be firm and obviously under negative pressure. If it does not, then examine and repair the dressing with the surgeon that placed it if available.

(3) Identify any areas at risk for leakage during flight:

Examine the edges of the dressing closely to determine whether there are areas at risk for developing leaks (i.e. skin folds, creases, dressings applied over hair). Address these areas by modifying or reinforcing the dressing prior to departing the MTF.

(4) Identify any undrained fluid under the dressing:

It is important to inspect the dressing for any undrained fluid building up under the dressing. If this fluid continues to accumulate, the dressing will ultimately separate from the skin with loss of the airtight seal, failure of the dressing to maintain suction, collection of fluid in the wound bed, and leaking of fluid from the dressing. If not corrected fairly quickly, the dressing may not be able to be repaired without completely replacing the entire dressing.

(5) Prepare extra supplies that may be necessary during flight:

Extra canisters, (2) Ioban and/or Tegaderm to reinforce the dressing if an in-flight leak develops, (3) benzoin or other topical adhesive to facilitate dressing adherence if repair is

required, (4) additional suction adjuncts such as additional bubble tubing, Y-connectors, and "football" connectors, and (5) a shaving razor to remove hair prior to dressing reapplication may all be required to successfully troubleshoot and repair a malfunctioning NPWT dressing.

(6) Determine the number of canisters required for flight:

- The VAC Freedom NPWT canisters are small (300 ml). They cannot be emptied or reused; the pump will automatically shut off when the canister is full.
- It is imperative that enough canisters are taken as extra supplies to last for the duration of the flight. Check the hourly wound output for the prior 24 hours to help estimate the number of required canisters. If the Impact suction is being used instead of the KCI pump, the impact canisters are larger and can be emptied and reused if absolutely necessary.

(7) Develop an in-flight NPWT failure plan:

Prior to departure, it is reasonable to discuss with the surgeon whether a particular NPWT dressing may be safely converted to a wet-to-dry dressing if equipment issues cannot be overcome. This is easiest in smaller wounds with minimal output.

(8) Consider power and outlet access:

- Electrical cable assembly system (ECAS) setups may support as few as 4-7 power outlets per patient. The number of wound VACs per patient may exceed this capability. Constant vigilance will be needed to ensure the wound VACs remain charged. Rotating power cords between devices may be necessary.
- Each VAC Freedom draws 1 ampere of power; this must be taken into consideration in pre-mission planning with AE.
- In the event of power cord shortage, the Ranger Glidescope power cable is compatible with the KCI VAC Freedom.

Addressing NPWT Dressing Failure in Flight

The most common problem CCAT teams face is the inability to maintain negative pressure. This is most commonly the result of a leak at the edge of the adhesive dressing.

Review of the KCI System Alarms

- **Leak detected alarm**: sounds if the device is unable to maintain negative pressure in the wound; strategies for repair are detailed below.
- **Tube obstructed alarm**: sounds if the tubing is obstructed or if the canister is full.
  - First check the canister and replace it if it is full; ensure the canister is properly seated on the pump. Replace the canister if no other causes are found.
  - Check the tubing to ensure that there are no clamps or blood clots occluding it.
  - Increasing the level of suction may help maintain tubing patency but this should generally only be done after consulting with the physician who placed the device, if possible.

How to detect the loss of negative pressure:

- The dressing (or dressings if "Y" connected) will no longer be firm and collapsed.
- The KCI alarm sounds.

  Note that there is no "loss of suction" alarm on the Impact suction device.

How to identify the site of a NPWT dressing leak:

- Begin with a thorough inspection of the pump, canister, and all tubing connections to quickly eliminate these as a source of suction loss.
- Leaks around the edges of the adhesive dressing are the most common source of leaks. To identify the exact leak site, push along the edge of the dressing in sections to determine if the leak seals with manual compression.
- Large leaks may make a hissing sound that may be detected by listening closely; this may be nearly impossible to detect in-flight due to aircraft noise, so check prior to departure.

How to repair a dressing if the leak site has been identified:

- Simple reinforcement with additional adhesive dressings can repair most leaks.
- Before placing a patch on the dressing (most commonly the edge with require repair), the skin should be thoroughly cleaned, dried, hair removed, and a supplemental adhesive (i.e. benzoin) should be applied to maximize the chances of a successful seal.
- In complex dressings with multiple wounds attached to a single suction source, it may be possible to preserve suction on the dressing by excluding a single wound that is responsible for the loss of pressure on the entire dressing. After excluding the wound with the leak, work to identify the leak in the dressing and repair if possible.

How to repair a dressing if the leak site could not be identified:

If no obvious leak source is identified, an attempt should be made to cover the entire existing adhesive dressing with a larger sheet of Ioban. Depending on the size and location of the wound, this may or may not be possible. Again, drying the original dressing and skin and following with benzoin may increase the chances of obtaining an airtight seal. Avoid circumferential limb dressings.

What to do if a dressing leak cannot be repaired:

- If efforts to resolve the loss of suction are unsuccessful, teams should resort to the contingency plan established before flight departure; discuss these options with the sending physician prior to departing the MTF. Depending on the remaining transport time, size/location of the wound, and wound output, one of the following strategies can be selected:

  1. Leave the dressing in place and attach Impact suction at higher suction level. The higher suction may help overcome losses from small leaks.
  2. Remove the dressing and replace with a traditional wet-to-dry dressing for any wound except for an abdominal or thoracic temporary closure. If you remove a VAC dressing, document number of sponges removed from the wound so that none are inadvertently left behind.

What to do if the equipment fails:

- If the KCI VAC Freedom fails in flight, it is usually appropriate to attach the dressing to a standard Impact suction device.
- In small extremity wounds with minimal output, it may be appropriate to switch to wet- to-dry dressings.

In-flight management and patient monitoring:

- Quantity and quality of drainage should be monitored hourly. Changes in either the quantity or character of the output should be discussed with the CCATT physician.
- The drainage should be monitored for frank blood; see the special considerations section for strategies to deal with bleeding from a NPWT dressing.
- Additional vigilance is required when using the Impact suction unit for NPWT as there are no alarms to alert the team to malfunctions or changes in output.
- For negative pressure therapy to extremities, document distal pulse exams hourly. If a change in pulse exam occurs, CCAT teams should urgently evaluate the reason for the change, and ensure that large or near-circumferential extremity dressings is not restricting blood flow due to worsening edema.[9]
- Negative pressure should be applied continuously to all NPWT dressings. Prolonged periods without suction allow fluid to accumulate in the wound, which will lead to dressing failure.
- Use padding to prevent pressure injury for wounds located on dependent areas of the body (i.e. back or buttock wounds on a supine patient).

Special Considerations

Placing a NPWT dressing directly over a vascular repair is contraindicated. However, if a vascular repair has good soft tissue coverage (i.e. muscle), a NPWT may be used to manage large associated soft tissue injuries. New or continuous bleeding from a wound with an underlying vascular repair should raise suspicion for failure of the vascular repair; this is an emergency that requires immediate attention. Significant bleeding can also occur from small branch vessels in the wound.

What to do if significant bleeding develops in-flight:

These steps apply to extremity/junctional wounds only, not to temporary abdominal or chest closures:

1. If a large amount of blood rapidly fills the wound VAC then apply manual pressure over the NPWT dressing, remove the suction, and call the other CCATT members for help.

2. If life-threatening bleeding from an extremity wound is identified (the patient is tachycardic or hypotensive):

    a. Maintain direct pressure over the wound and have a second CCATT member place a CAT tourniquet 2-3 inches proximal to the wound and tighten it until the bleeding stops. The NPWT dressing can be removed and the wound tightly packed with Kerlix or Combat Gauze and then wrapped with an ACE bandage or Coban. Arrange for a diversion to the nearest surgical facility.

b. Next decide when to release the tourniquet. This decision should involve the surgeon from the sending facility, if possible. Factors to consider are the patient's hemodynamic status, blood availability, experience level of the provider with packing surgical wounds, likelihood of arterial bleeding, and the projected time of arrival at a surgical facility. The tourniquet time should be less than 2 hours, if possible.

3. If extremity wound bleeding is significant but not life-threatening (the patient is normotensive and not tachycardic):

   a. Maintain direct pressure over the wound and have a second CCATT member position a CAT tourniquet 2-3 inches proximal to the wound; the tourniquet does not have to be tightened, but rather pre-positioned if bleeding worsens. The NPWT dressing can be removed and the wound tightly packed with Kerlix or Combat Gauze; and then the entire limb can be wrapped with an ACE bandage or Coban.

   b. If bleeding is significant during packing, then the tourniquet can be tightened for control until wound packing and pressure dressing are completed.

   c. Wound packing and a pressure dressing can control most wound bleeding. A surgical consult would be appropriate; consider emergency diversion if bleeding is not controlled.

4. If life-threatening bleeding is identified from a groin or axilla junctional wound (the patient is hypotensive or tachycardic):

   a. If direct pressure does NOT control the bleeding, rapidly remove the NPWT dressing, pack the wound with Combat Gauze or Kerlix, and again apply direct pressure. Divert to the nearest surgical facility; obtain an in-flight surgical consult.

   b. If direct pressure over the NPWT dressing DOES control the bleeding (the NPWT dressing no longer fills with blood), continue holding pressure and consult surgery in-flight.

   c. Next decide whether the NPWT dressing should be removed to pack the wound. This decision should involve the surgeon from the sending facility, if possible. Factors to be considered are the patient's hemodynamic status, blood availability, experience level of the provider with packing surgical wounds, likelihood of arterial bleeding, presence of a vascular repair, and the projected time of arrival at a surgical facility.

   d. If the patient-to-CCATT ratio allows, maintain manual pressure using a team member rather than converting to a junctional tourniquet as manual pressure may be more reliable. Placement of the junctional tourniquet is not always straightforward and may increase limb ischemia.

5. If non-life-threatening bleeding is identified from a groin or axillary junctional wound (the patient is not hypotensive or tachycardic):

   Remove the NPWT dressing and pack the wound tightly and apply a pressure dressing to the entire limb. The junctional tourniquet can be used (may not need to be fully inflated) to maintain pressure if manual compression cannot be maintained because CCATT members cannot be spared from other patient care. Emergency diversion should be considered; an in-flight surgery consult would be appropriate.

6. Bleeding from a neck wound can be managed with direct pressure, then remove NPWT dressing followed by wound packing as described above. Emergency diversion should be considered for surgical evaluation; discuss with sending surgeon in-flight.

7. Anticipate resuscitate requirements for a bleeding patient. Do not wait for shock to develop. Replace blood with blood, not crystalloid.

What to do for small amounts of bloody output:

If bleeding develops from a NPWT dressing that doesn't cover a vascular repair, and if the volume is small, monitor the character and volume of output and consider reducing the suction. Reducing the suction may decrease the wound output, but it may also allow buildup of blood under the sponge where you can't see it. If there is concern about persistent ongoing active bleeding, get help and good lighting and remove the dressing, control the bleeding if possible, and pack the wound with Kerlix or Combat Gauze and wrap the limb with an ACE bandage or Coban.

The open abdomen:

- A leak from a NPWT dressing on an open abdomen may rapidly progress to evisceration if not repaired. A malfunctioning open abdomen dressing should be aggressively repaired in flight but not removed/replaced. (See strategies for NPWT failure in flight.) Chemical paralysis will help reduce the chance of evisceration in the event of malfunctioning open abdomen dressing.
- A temporary abdominal closure does not always evacuate all the blood in the abdomen, so it is possible for a patient to bleed into their abdominal cavity without a significant increase in the wound VAC output. This diagnosis requires close observation and continuous evaluation of hemodynamics. Markers of intravascular volume status (i.e. urine output, PPV, base deficit, TTE) should be also used.
- It is important to recognize that abdominal compartment syndrome can occur in spite of an open abdomen. If there is clinical suspicion (hypotension, low urine output, elevated peak airway pressures on the ventilator in volume mode), assess intraabdominal pressure by transducing a bladder pressure – greater than 20 mmHg may indicate abdominal compartment syndrome.

The open chest:

A chest that has been temporarily closed should have a chest tube(s) placed inside the chest, as well as a suction catheter coming from the wound itself. The chest tubes AND the suction catheter need to be kept to suction per surgeon instructions, and the output from all chest drains needs to be monitored hourly. A malfunctioning NPWT on an open chest should undergo troubleshooting but not removed/replaced in-flight.

Fixed (Expected Clinical Proficiency)

CCATT members are expected to understand the following:

1. The KCI VAC Freedom system.
2. The open abdomen and chest NPWT dressing.
3. The instillation NPWT dressing.
4. The troubleshooting and repair of the various NPWT dressings encountered in the AE environment.

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Appendix A: Use of Impact Suction

This appendix describes one way to use the Impact suction if the KCI pump malfunctions in-flight.

1. Cut the NPWT/KCI tubing approximately one inch from the white connector on the canister side (left arrow). Cutting the tube on the canister side (not the wound side, right arrow) will allow a new KCI pump to be reconnected without forcing a NPWT dressing change/repair first. See Figure 1.

2. Place bubble tubing over the cut end of the tubing and partially push it over the white connector (marked by arrow) to create a seal; see Figure 2).

Figure 1

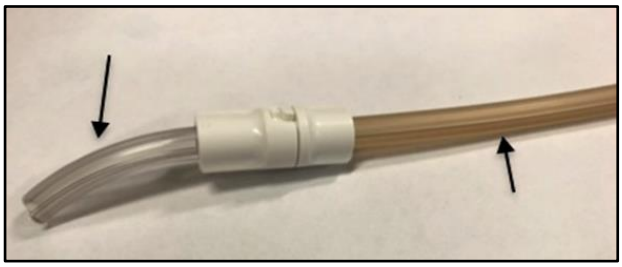
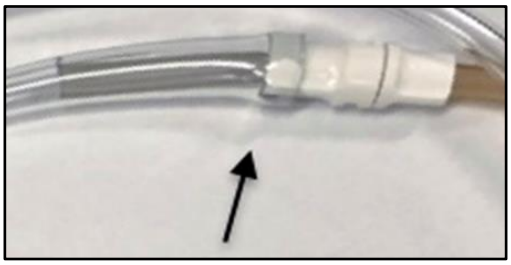


Figure 2



3. The bubble tubing can now be connected to the Impact suction as shown in Figure 3.

4. Ensure the suction strength is adjusted to reflect the surgeon's orders. For example, -125 mm Hg is approximately four green lights on the digital indicator, left side Figure 4.

Figure 3

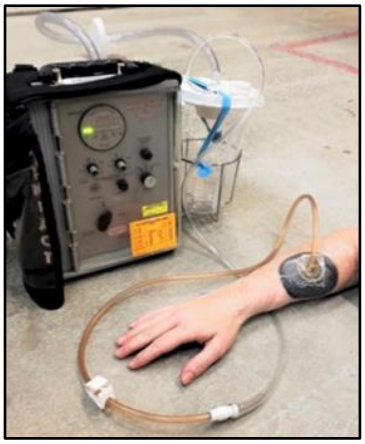
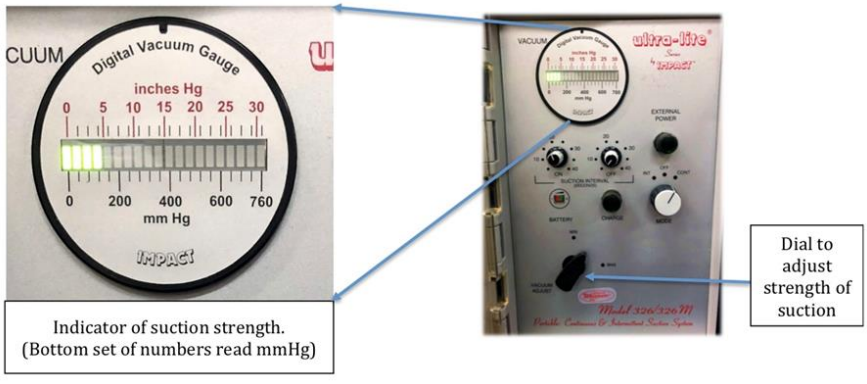
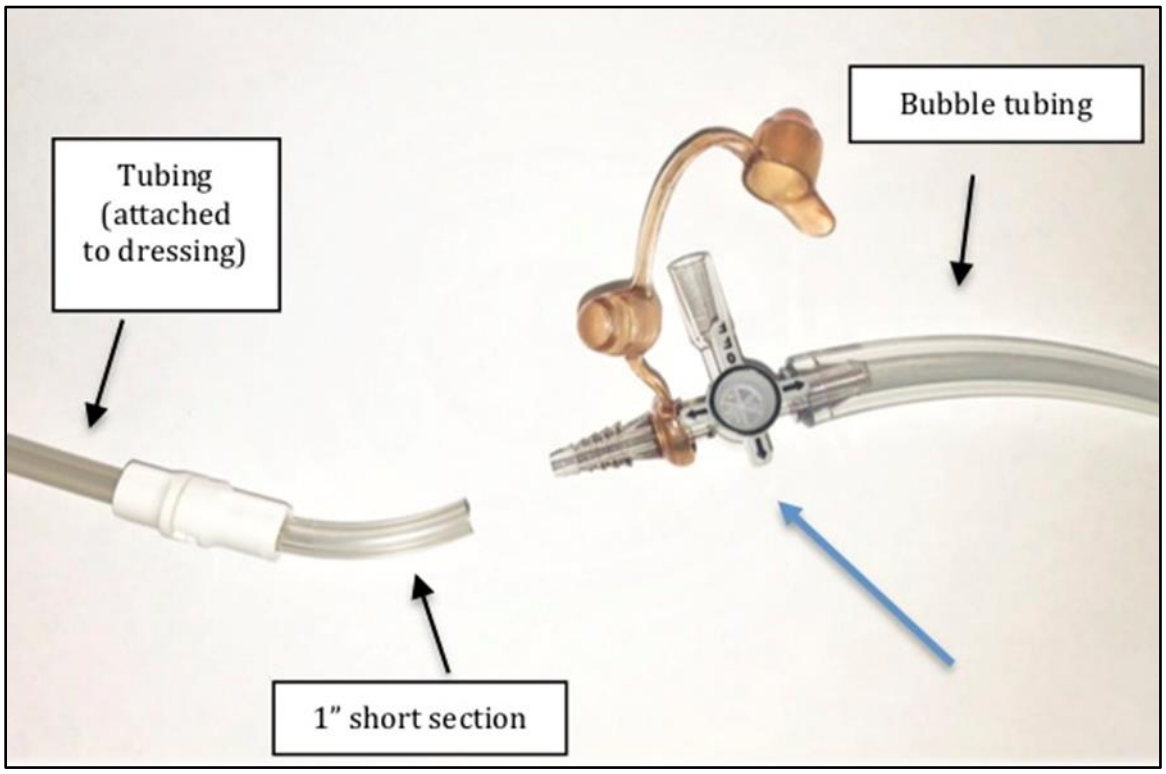


Figure 4



Appendix B: How to Construct an Instillation or Irrigation NPWT dressing

Refer to instructions below.



1. Cut the NPWT/KCl tubing approximately one inch from the white connector on the canister side.
2. Attach 3-way enteral stopcock (large arrow) between the bubble tubing and the one-inch short section; the other end of the bubble tubing connects to the suction.
3. Connect the two tubing sections in the figure to complete the NPWT circuit.
4. Irrigation procedure:
    a. Turn stopcock off to "suction."
    b. Instill medication.
    c. Keep suction off during medication dwell time (defined by surgeon.)
    d. Turn stopcock off to "syringe" and resume suction at previous settings.
5. Identify additional supplies and solution that will be needed during flight and retrieve items from the MTF prior to departure.
6. Using the impact suction is preferred because it has a larger capacity to collect irrigant and wound output.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Nursing Intervention in Prolonged Field Care (CPG ID: 70)

The intent of this guideline is to provide medical professionals who encounter extended casualty evacuation times in austere environments the evidence-based guidance for nursing interventions necessary to improve patient outcome.

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INTRODUCTION

This Role 1, prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines when evacuation to a higher level of care is not immediately possible. A provider of PFC first must be an expert in TCCC. The intent of this guideline is to provide medical professionals who encounter extended casualty evacuation times in austere environments the evidence-based guidance for nursing interventions necessary to improve patient outcomes. Recommendations follow a "minimum, better, best" format that provides alternate or improvised methods when optimal hospital options are unavailable.

Basic activities of daily living become impaired or nonexistent depending on the severity of wounds. Simple tasks such as brushing teeth, breathing, drinking, coughing, moving extremities, and turning become impossible for an injured or unconscious patient. Thus, the patient requires regular assessments and nursing interventions to monitor their condition and prevent the development of complications.

Nursing interventions may not appear important to the medical professionals caring for a patient, but such interventions greatly reduce the possibility of complications such as deep vein thrombosis (DVT), pneumonia, pressure sores, wound infection, and urinary tract infection. Critically ill and injured casualties are at high risk for complications that can lead to adverse outcomes such as increased disability and death. Nursing care is a core principle of PFC to reduce the risk of preventable complications and can be provided without costly or burdensome equipment.

Using a nursing care checklist assists with developing a schedule for performing appropriate assessments and interventions.

Cross-training all team members on these interventions prior to deployment will lessen the demand on the medic, especially when caring for more than one patient.

ASSESSMENT

After initial stabilization, every patient requires regular assessments. Document results on a PFC flowsheet (Appendix A) and monitor trends to identify signs of decompensation. Initiate nursing interventions early to prevent further harm.

- **Minimum**: Manual blood pressure (BP) cuff, stethoscope, thermometer, pulse oximeter, glucometer, urinary catheter, flashlight, watch
- **Better**: Digital, wrist BP cuff
- **Best**: Portable monitor providing continuous vital signs display and capnography capability, glucometer

VITAL SIGNS

- Obtain BP, heart rate, respiratory rate, temperature, oxygen saturation, end-tidal CO2 (when available), Glasgow Coma Scale score, pain score, and peripheral pulses.
- Inspect and Monitor Tubes
- Examine all tubes (e.g., endotracheal tube [ETT] or cricothyroid tube, nasogastric [NG] tube, intravenous [IV] line, chest tube, urinary catheter) for correct placement and appropriate function, and ensure they are secured properly.

- High-volume burn resuscitation results in global edema and ETT/cricothyroid tube position must be closely monitored. Securing tubes with circumferential ties is required when burned skin weeps fluid.

***Caution**: NG tubes should only be placed when radiographic or intraoperative confirmation is available, or when the benefit outweighs the risk. Routine NG placement for unconscious or intubated patients is not recommended in austere environments.*

MONITOR INPUT AND OUTPUT

- Check IV drip rate or give oral fluids as needed.
- Ensure adult patients void an average of 30–50mL/h, or 100–200mL/h if exhibiting signs of rhabdomyolysis.
- Check drainage from wounds and tubes.

INSPECT SKIN AND SPLINTS

Examine skin, including nares and mouth, for changes and ensure splints are fitted properly and pulses are present below splint. Monitor for allergic reactions to tape, developing erythema, excessive dryness, pressure indenting the skin, cracking, or breakdown.

Nursing Interventions

Applicable nursing interventions are identified and adjusted after every assessment is completed. Interventions are individualized on the basis of each patient's illness or injury. Different interventions may be required depending on a patient's level of consciousness, and a previously conscious patient may become unconscious. Positioning a patient in a comfortable position with head and injured extremities elevated is a basic and important intervention; one positioning method is to use a trifold lawn chair, or similar improvised support, to maintain elevation of the patient's head and legs as needed.

The PFC nursing care plan (Appendix B) is a chart of nursing interventions with recommended intervals that the primary medical professional can fill out for the team to continue caring for a patient while the primary medical professional rests. Before deployment, medical professionals can use this tool to train teammates on nursing interventions so they can assist with patient care. Appendix C is an example of a completed chart with instructions.

PLAN AND DOCUMENT NURSING INTERVENTIONS

Minimum: Nursing care checklist portion of the PFC flowsheet (Appendix A)

Best: PFC nursing care plan (Appendix B)

FLUSH SALINE LOCKS

- **Minimum**: Empty 10mL syringe, needle, bag of normal saline (NS), alcohol pads
- **Best**: Prefilled 10mL NS syringes, needle (if applicable), alcohol pads

At least every 8 hours, flush saline locks with 10mL of NS.

1. Gather equipment.

2. Clean access port with alcohol pad.
3. Take prefilled 10mL syringe of NS and needle (if applicable) or attach syringe to port.
4. With constant pressure, inject NS into port to flush catheter to ensure line remains open.
5. If resistance is met, gently use pulsating pressure on end of syringe until NS flows freely.
6. Carefully observe the IV site for swelling or pain. Start a new IV if swelling or pain occurs.
7. Detach syringe and dispose; place needle in sharps container (if applicable).

If prefilled syringes are unavailable, draw up NS into unused, empty syringe from a bag of NS, then follow steps above.

SUCTION ADVANCED AIRWAY

- **Minimum**: Manual suction device or improvised suction device, such as a 25cm length portion of IV tubing connected to a 60mL syringe
- **Better**: Open suction tube, suction machine
- **Best**: Closed inline suction tube, suction machine

Perform airway suction only when needed, using sterile technique for advanced airways or clean technique for the mouth and throat. Humidify the air using a humidifier, moist gauze, or by boiling a pot of water.

1. Gather necessary equipment.
2. Ensure patient's head is elevated.
3. Perform hand hygiene.
4. Place a clean towel under patient's chin.
5. Don eye protection.
6. Hyperventilate patient for 10 seconds.
7. Perform appropriate suctioning with available equipment (ensuring suction is performed while withdrawing the catheter for no longer than 10 seconds at a time).
8. Allow at least 30 seconds before repeating suctioning, if needed.
9. Perform oral care as needed but at least every 4 hours.

REPOSITION AND CHECK PADDING

- **Minimum**: Extra clothing, soft items
- **Best**: Pillows, blankets, towels

Identify patients who cannot reposition themselves. Reposition patient and check padding at least every 2 hours. To prevent ischemic tissue injury and the formation of pressure sores, frequent movement of the patient

is necessary. Relieving pressure from superficial capillaries allows the skin to recover from the temporary ischemia.

1. Roll the patient onto one side (if concerned about spine injury, carefully log roll while maintaining spine stabilization).
2. Have an assistant remove pillows, blankets, or soft items being used for positioning and gently guide the patient down onto their back.
3. Using the same procedure, have assistant gently roll patient in the opposite direction.
4. Place pillows, blankets, or soft items under patient for positioning and have assistant guide patient back down.
5. Ensure the patient's ankles, knees, and elbows are not resting on top of each other and arms are not resting on the abdomen, by placing padding between them.
6. Ensure the patient's head and neck are in line with the spine.
7. Use additional padding items for bony prominences on hard surfaces.
8. Ensure creases and bumps in clothing, sheets, and blankets are smoothed out under the patient.
9. Be aware of the location of external equipment such as Foley catheter, IV tubing, and ventilator tubing to prevent dislodging during repositioning.
10. If any areas of nonblanchable erythema are noted, outline area with marker and prevent placing patient on the affected area until it recovers.
11. Burned and injured extremities should be slightly elevated and slightly flexed to optimize venous return and maintain adequate peripheral pulses.

ORAL CARE

- **Minimum**: Gloves, gauze, lip moisturizer
- **Better**: Mouth wash, mouth moisturizer, gloves, gauze, tongue depressor, tape, lip moisturizer
- **Best**: Oral cleansing and suction system, lip moisturizer

Good oral hygiene reduces oropharyngeal colonization, which is associated with ventilator-acquired pneumonia. Patients who are conscious and able should brush their teeth a minimum of every 12 hours. For unconscious patients, perform oral care at least every 4 hours. Ensure some type of suction is available (e.g., manual suction device, syringe with IV tubing).

- To keep the patient's mouth open, make a padded tongue depressor by wrapping gauze around one end of it and securing with tape.
- If available, use swab and chlorhexidine gluconate rinse from oral cleansing and suction system. Make sure not to oversaturate the swab to avoid aspiration of fluid. Clean teeth and oral cavity for approximately 1 minute. If the system is unavailable, use a 2×2 gauze wrapped around pointed gloved finger and hold firmly with the rest of hand. Moisten the gauze with mouthwash (ensuring not to oversaturate) and gently clean the teeth and mouth cavity. Multiple gauze swabs may be needed depending on the level of contamination in the mouth. Follow up with mouth moisturizer if available.

- Apply lip moisturizer.

FOLEY CATHETER CARE

Minimum: Basin, warm water, nonirritating soap, linen saver pad, towels

Perform Foley care once a day or as needed for excessive drainage.

1. Wash hands thoroughly with soap and water, apply gloves, and place linen-saver pad or dry towels under patient.
2. Using mild soap and water, clean genital area.
3. For male patient: retract the foreskin, if needed, and clean the area, including the penis.
4. For female patient: separate the labia, and clean the area from front to back.
5. Clean urethra (urinary opening), where the catheter enters the body.
6. Clean the catheter from where it enters the body and then down, away from urethra. Hold the catheter at the point it enters the patient so that tension is not placed on it.
7. Rinse the area well, dry gently, and replace linen-saver pad under patient.

WASH AND DRY SKIN, APPLY LOTION

- **Minimum**: Water, gauze, or well rinsed "baby" wipes
- **Bette**r: Bowl, baby or mild wash, unscented lotion, 2×2 and 4×4 gauze pads, gloves, tongue depressor, tape
- **Best**: Basin, linen-saver pads, disposable wash cloths, compression stockings, trifold lawn chair, nasal mist, pillows, padding, urine test strips, toothbrush and toothpaste, oral cleansing and suctioning kit, tongue depressor, gauze, tape

At least once per day or as needed, wash, dry, and apply lotion to skin. Cleaning the skin is an opportunity to evaluate additional injuries and visualize any new areas of erythema.

1. Prepare basin or bowl with warm water and a small amount of baby wash.
2. Obtain multiple 4×4 gauze pads or clean washcloths and place in water
3. Expose body part to be washed, keeping the rest of the patient covered, and place linen-saver pad under the area to absorb water.
4. Take one gauze or washcloth out of the basin and wring out excess water. Wash skin a little bit at a time, throwing away used gauze or washcloths until clean. DO NOT place contaminated gauze or washcloths back into basin or bowl.
5. Wash face first and genitalia last. (Cleaning genitalia is detailed under Foley care.)
6. Ensure the skin is thoroughly dried, including all skin folds, and apply lotion.

***Caution**: If baby wipes or skin wipes are used to wash the skin, the wipes should be thoroughly rinsed with water first, because most contain alcohol and residues that can irritate the skin.*

CHANGE INTRAVENOUS BAG AND TUBING

Every 72 hours if possible, replace infusing bag of fluids and tubing with new equipment. If fluids infusing at a to-keep-open rate and a bag has been up for 72 hours, ensure a fresh bag and tubing are hung and marked with new time and date.

CHECK BLOOD GLUCOSE LEVEL

If available, check blood glucose level (BGL) every 8 hours or more frequently as dictated by patient status. A low BGL (less than 80 mg/dL) must be treated immediately with oral sugar or juice or IV glucose. A high BGL (greater than 200 mg/dL) is less dangerous than low glucose, but may be treated if the capability is available.

CHANGE TAPE

1. Once a day, change tape on patient's skin (except for peripheral IV sites, which can be changed every 72 hours to avoid exposing puncture site to contaminants). Daily tape changes decrease the potential for skin breakdown. This intervention may be accomplished after patient's daily wash.
2. For ETT or cricothyroid tube, gently remove tape. If tape is strongly adhered, use an alcohol swab to moisten the top of the tape. As the tape is lifted back, use the alcohol swab and gently rub across the skin at the junction with tape to loosen, ensuring not to dislodge tube placement.
3. For ETT, after tape is removed, gently move the tube to the opposite side of the mouth, again ensuring not to dislodge it or rest on lip.
4. Apply new tape to a section of skin next to where tape was previously removed. To give skin a break, do not place over the same area.

LOWER EXTREMITY MASSAGE, DVT PREVENTION

If available, compression stockings, or elastic bandages (wrapped starting from the toes upward) should be placed on immobile or unconscious patients, ensuring toes remain exposed for capillary refill assessment. Patients who are conscious and able may perform the following exercises, completing 10 repetitions of each exercise every hour while awake. This may be done in burned extremities or in the presence of open wounds, but should be avoided when fractures or severe extremity injuries are present.

- **Foot pumps**. Have the patient stretch toes up and back, flexing feet, and hold for a few seconds. Then point toes and hold before repeating.
- **Ankle circles**. Have patient raise both feet and trace a circle or each letter of the alphabet with their toes
- **Leg raises**. With left leg straight, have the patient raise foot off the bed or floor, then lower. Repeat with right leg. Alternatively, slowly have patient lift left knee up to chest, then bring foot back to the bed or floor; repeat with right leg.
- **Thigh stretches**. While patient is lying on their back with straight legs, have them raise one leg to 90°. Instruct patient to pull the leg gently toward the head and hold for up to 30 seconds. Slowly bring leg back down to a flat position, and repeat with other leg.

- **Shoulder rolls**. Although developing a clot in the upper body is not likely, blood still needs to keep flowing. Have the patient raise shoulders and circle them back and down five times. Then reverse direction for five more repetitions.

Perform DVT prevention for unconscious patients at least every 2 hours.

- **Ankle plantarflexion-dorsiflexion**. Hold the ankle and heel of one foot and alternately bend the foot forward into plantarflexion and then push the foot upward into dorsiflexion. Hold each position for 5–10 seconds.
- **Lower extremity massage**. Using both hands and starting at the ankle, apply consistent pressure, massaging the leg in an upward motion through the thigh. (Items such as a plastic bottle may be used to roll the skin toward the head.) Ensure deep pressure is avoided when massaging behind the knee or over bony prominences. Alternate legs (to simulate walking) for five times on each leg.

RANGE OF MOTION EXERCISES

At least every 8 hours, perform range of motion exercises on all movable joints such as ankles, knees, hips, wrists, fingers, elbows, and shoulders, except where joint mobility is restricted by injury.

TURN, COUGH, DEEP BREATHE

1. For a conscious patient, encourage them to turn, cough, and take deep breaths to prevent atelectasis.
2. Instruct the patient to breathe in deeply and slowly through their nose, expanding lower rib cage, and letting abdomen move forward.
3. Hold for a count of 3 to 5.
4. Instruct patient to breathe out slowly and completely through pursed lips.
5. Have patient rest and repeat 10 times every hour.
6. Code Brown: Unconscious Patient Bowel Movement Recommend leaving unconscious patients unclothed from the waist down and covered with a sheet or blanket, with linen-saver pad or towel under the buttocks for easy bowel movement clean up. During assessment, check if the unconscious patient has had a bowel movement and clean if needed.
7. Gather a basin with warm, soapy water; rolled linen-saver pad or towel; gloves; and washcloths.
8. Have assistant log roll the patient toward them.
9. Start cleaning from top of patient toward soiled linen-saver pad or towel, obtain a new washcloth when current one is completely used.
10. When patient is cleaned as far as can be reached on that side, roll soiled pad or towel on itself to contain fecal matter and start to unroll new linen-saver pad, keeping clean one under dirty one.
11. Gently log roll patient to the other side and have assistant finish cleaning soiled area; dry completely.
12. Discard soiled pad or towel and finish unrolling clean pad, ensuring there are no folds under patient.
13. Gently roll patient to previous position of comfort and cover.

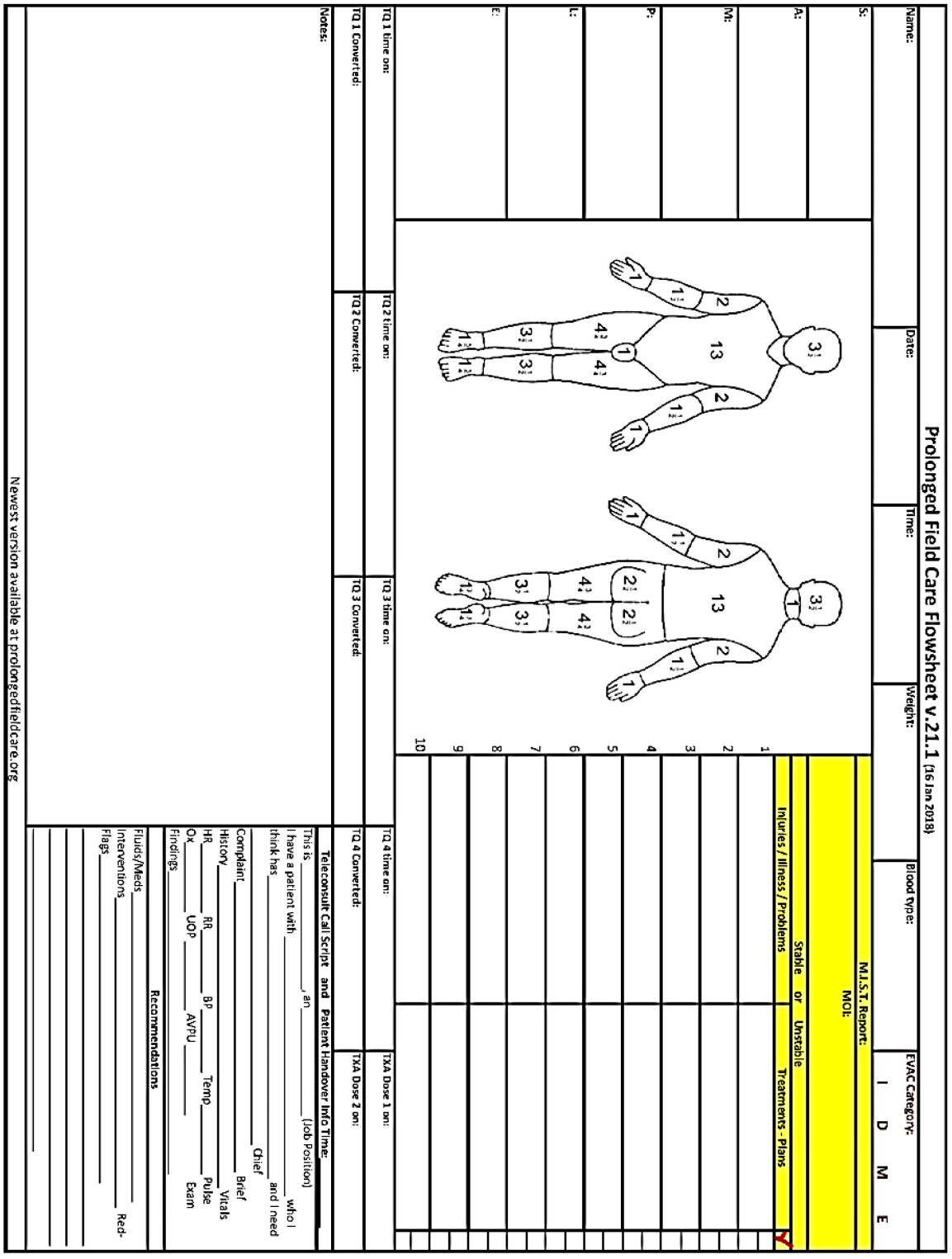
14. For nursing assessment and intervention packing list, see Appendix D.

15. Hospital clinical rotations are an excellent opportunity to learn and practice nursing assessments and interventions. The recommended nursing skills checklist for clinical rotations is included in Appendix E.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- Morbidity and Mortality Conference Reports

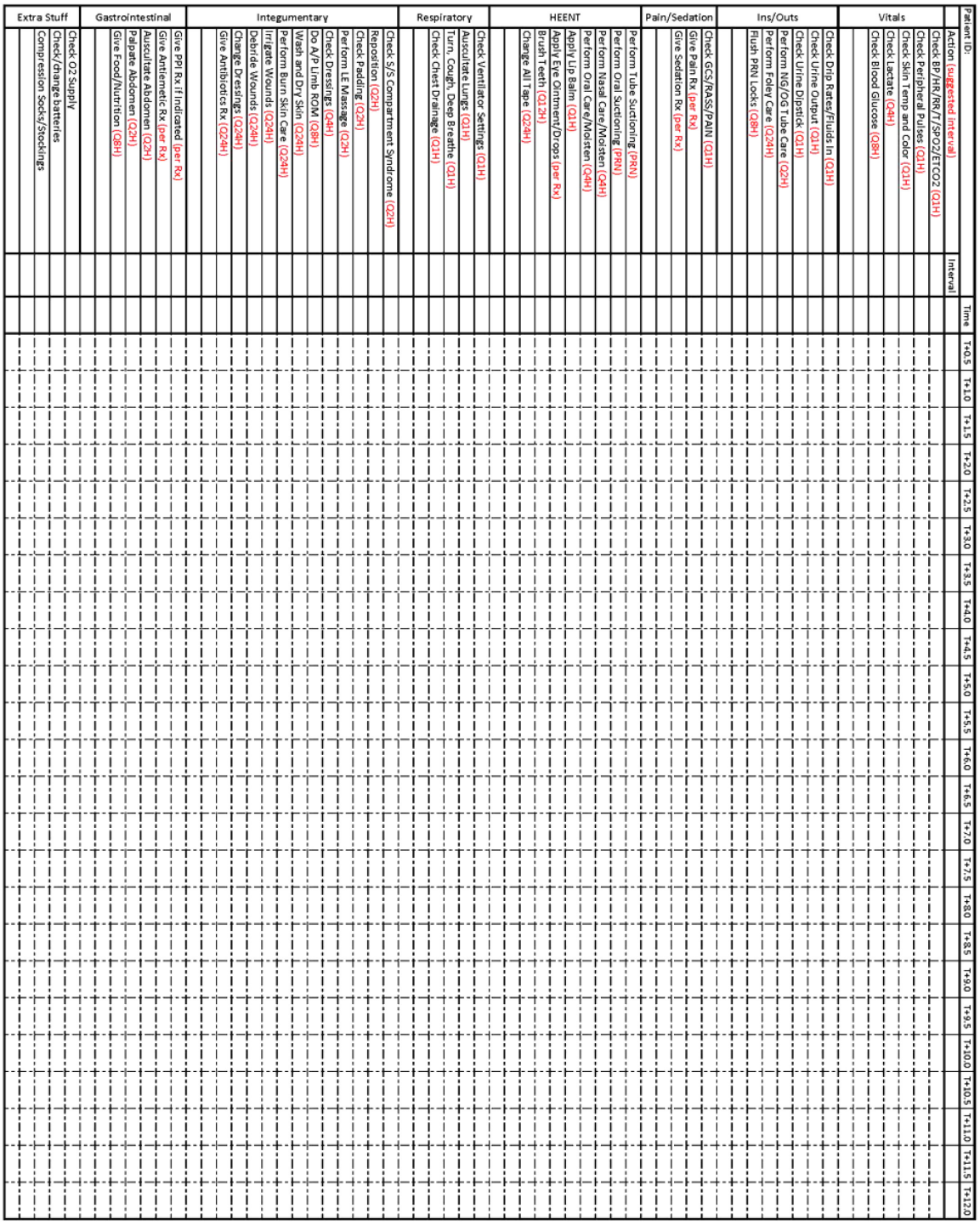
APPENDIX A: PROLONGED FIELD CARE FLOWSHEET



Prolonged Field Care Flowsheet v.21.1 (16 Jan 2018)

| | Day | | |

APPENDIX B: PFC NURSING CARE 12/24 HR - BLANK



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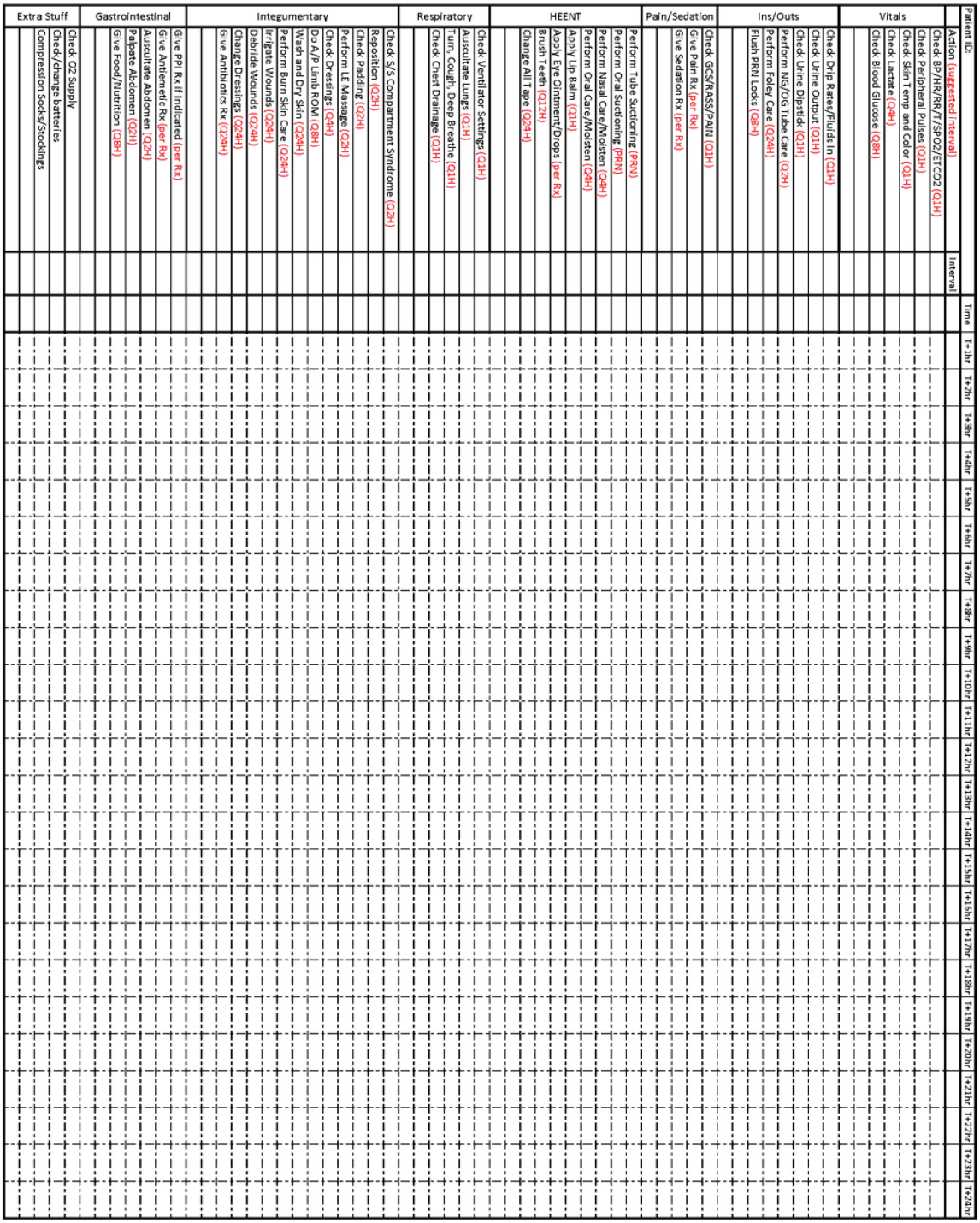
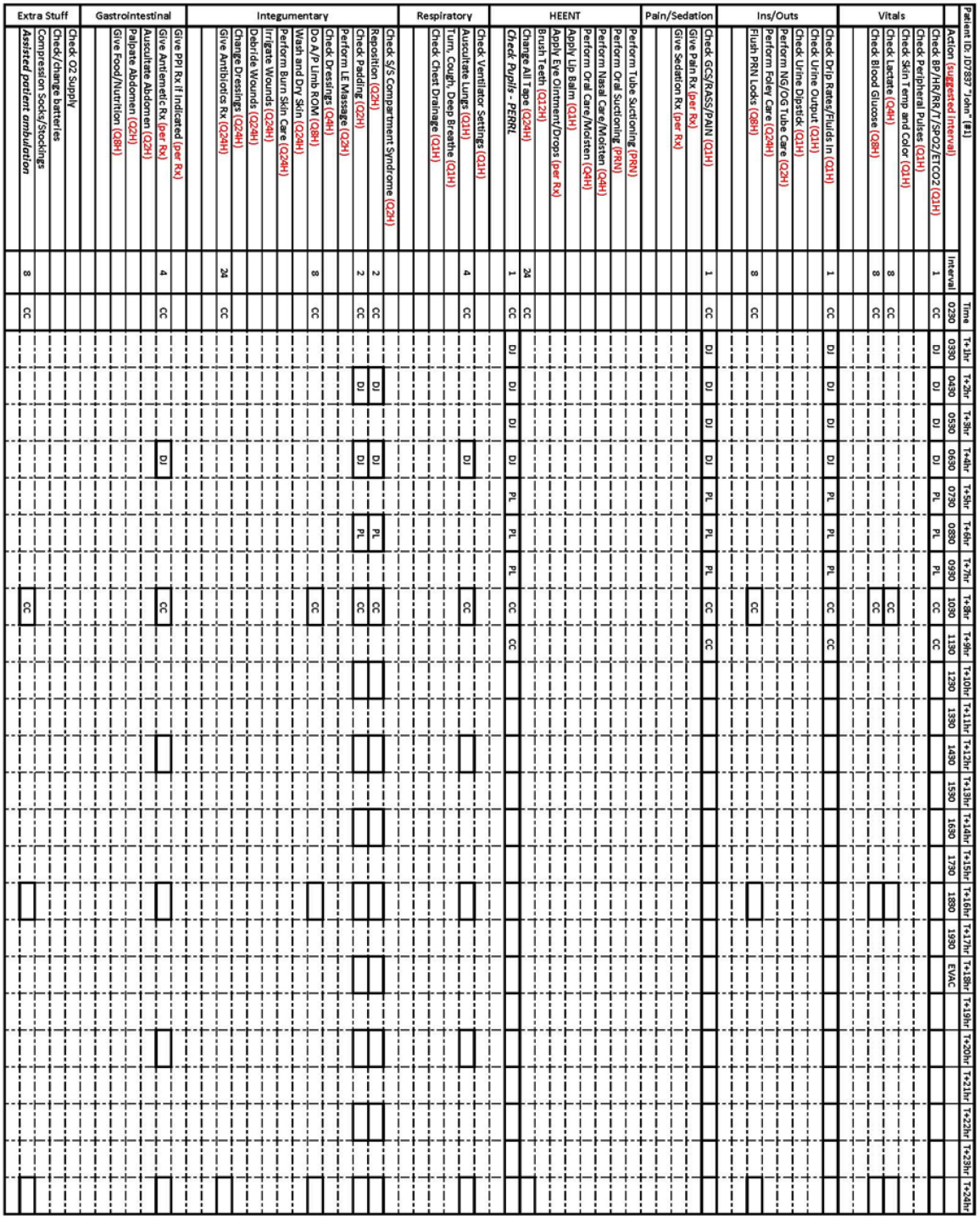


24 Hour Care Plan

Patient ID:																									
			Time	T+1hr	T+2hr	T+3hr	T+4hr	T+5hr	T+6hr	T+7hr	T+8hr	T+9hr	T+10hr	T+11hr	T+12hr	T+13hr	T+14hr	T+15hr	T+16hr	T+17hr	T+18hr	T+19hr	T+20hr	T+21hr	T+22hr	T+23hr	T+24hr
	Action (suggested interval)	Interval																								
Vitals	Check BP/HR/RR/T/SPO2/ETCO2 (Q1H)																									
	Check Peripheral Pulses (Q1H)																									
	Check Skin Temp and Color (Q1H)																									
	Check Lactate (Q4H)																									
	Check Blood Glucose (Q8H)																									
Ins/Outs	Check Drip Rates/Fluids In (Q1H)																									
	Check Urine Output (Q1H)																									
	Check Urine Dipstick (Q1H)																									
	Perform NG/OG Tube Care (Q2H)																									
	Perform Foley Care (Q24H)																									
	Flush PRN Locks (Q8H)																									
Pain/Sedation	Check GCS/RASS/PAIN (Q1H)																									
	Give Pain Rx (per Rx)																									
	Give Sedation Rx (per Rx)																									
HEENT	Perform Tube Suctioning (PRN)																									
	Perform Oral Suctioning (PRN)																									
	Perform Nasal Care/Moisten (Q4H)																									
	Perform Oral Care/Moisten (Q4H)																									
	Apply Lip Balm (Q1H)																									
	Apply Eye Ointment/Drops (per Rx)																									
	Brush Teeth (Q12H)																									
	Change All Tape (Q24H)																									
Respiratory	Check Ventilator Settings (Q1H)																									
	Auscultate Lungs (Q1H)																									
	Turn, Cough, Deep Breathe (Q1H)																									
	Check Chest Drainage (Q1H)																									
Integumentary	Check S/S Compartment Syndrome (Q2H)																									
	Reposition (Q2H)																									
	Check Padding (Q2H)																									
	Perform LE Massage (Q2H)																									
	Check Dressings (Q4H)																									
	Do A/P Limb ROM (Q8H)																									
	Wash and Dry Skin (Q24H)																									
	Perform Burn Skin Care (Q24H)																									
	Irrigate Wounds (Q24H)																									
	Debride Wounds (Q24H)																									
	Change Dressings (Q24H)																									
	Give Antibiotics Rx (Q24H)																									
Gastrointestinal	Give PPI Rx If Indicated (per Rx)																									
	Give Antiemetic Rx (per Rx)																									
	Auscultate Abdomen (Q2H)																									
	Palpate Abdomen (Q2H)																									
	Give Food/Nutrition (Q8H)																									
Extra Stuff	Check O2 Supply																									
	Check/change batteries																									
	Compression Socks/Stockings																									

APPENDIX C: PFC NURSING CARE PLAN - EXAMPLE



24 Hour Care Plan

Patient ID: ID7887 "John" (#1)			T+1hr	T+2hr	T+3hr	T+4hr	T+5hr	T+6hr	T+7hr	T+8hr	T+9hr	T+10hr	T+11hr	T+12hr	T+13hr	T+14hr	T+15hr	T+16hr	T+17hr	T+18hr	T+19hr	T+20hr	T+21hr	T+22hr	T+23hr	T+24hr
Action (suggested interval)		0230	0330	0430	0530	0630	0730	0830	0930	1030	1130	1230	1330	1430	1530	1630	1730	1830	1930	EVAC						
Vitals																										
Check BP/HR/RR/T/SPO2/ETCO2 (Q1H)	1	CC	DJ	DJ	DJ	DJ	PL	PL	PL	CC	CC															
Check Peripheral Pulses (Q1H)																										
Check Skin Temp and Color (Q1H)																										
Check Lactate (Q4H)	8	CC								CC																
Check Blood Glucose (Q8H)	8	CC								CC																
Ins/Outs																										
Check Drip Rates/Fluids In (Q1H)	1	CC	DJ	DJ	DJ	DJ	PL	PL	PL	CC	CC															
Check Urine Output (Q1H)																										
Check Urine Dipstick (Q1H)																										
Perform NG/OG Tube Care (Q2H)																										
Perform Foley Care (Q24H)																										
Flush PRN Locks (Q8H)	8	CC								CC																
Pain/Sedation																										
Check GCS/RASS/PAIN (Q1H)	1	CC	DJ	DJ	DJ	DJ	PL	PL	PL	CC	CC															
Give Pain Rx (per Rx)																										
Give Sedation Rx (per Rx)																										
HEENT																										
Perform Tube Suctioning (PRN)																										
Perform Oral Suctioning (PRN)																										
Perform Nasal Care/Moisten (Q4H)																										
Perform Oral Care/Moisten (Q4H)																										
Apply Lip Balm (Q1H)																										
Apply Eye Ointment/Drops (per Rx)																										
Brush Teeth (Q12H)																										
Change All Tape (Q24H)	24	CC																								
Check Pupils - PERRL	1	CC	DJ	DJ	DJ	PL	PL	PL	PL	CC	CC															
Respiratory																										
Check Ventilator Settings (Q1H)																										
Auscultate Lungs (Q1H)	4	CC			DJ					CC																
Turn, Cough, Deep Breathe (Q1H)																										
Check Chest Drainage (Q1H)																										
Integumentary																										
Check S/S Compartment Syndrome (Q2H)																										
Reposition (Q2H)	2	CC		DJ		DJ		PL		CC																
Check Padding (Q2H)	2	CC		DJ		DJ		PL		CC																
Perform LE Massage (Q2H)																										
Check Dressings (Q4H)																										
Do A/P Limb ROM (Q8H)	8	CC								CC																
Wash and Dry Skin (Q24H)																										
Perform Burn Skin Care (Q24H)																										
Irrigate Wounds (Q24H)																										
Debride Wounds (Q24H)																										
Change Dressings (Q24H)																										
Give Antibiotics Rx (Q24H)	24	CC																								
Gastrointestinal																										
Give PPI Rx if indicated (per Rx)																										
Give Antiemetic Rx (per Rx)	4	CC			DJ					CC																
Auscultate Abdomen (Q2H)																										
Palpate Abdomen (Q2H)																										
Give Food/Nutrition (Q8H)																										
Extra Stuff																										
Check O2 Supply																										
Check/change batteries																										
Compression Socks/Stockings																										
Assisted patient ambulation	8	CC								CC																

APPENDIX D: ASSESSMENT AND INTERVENTION PACKING LIST

The following list incorporates equipment categorized as "Best" although item substitutions categorized as "Minimum" may be described throughout performance steps.

- ☐ Portable Monitor
- ☐ Blood Pressure Cuff/Stethoscope/pulse oximeter
- ☐ Gloves
- ☐ Thermometer
- ☐ Urinary catheter
- ☐ Linen-saver pads
- ☐ Watch
- ☐ Oral Cleansing and Suctioning Kit/Toothbrush/Toothpaste/Mouthwash/Tongue depressor
- ☐ Lip balm
- ☐ Nasal mist
- ☐ Baby/mild wash
- ☐ Unscented lotion
- ☐ Compression stockings
- ☐ Pillows/Blankets/HPMK/Padding
- ☐ Basin/Bowl
- ☐ Suction device
- ☐ Tri-fold lawn chair
- ☐ Flashlight or headlamp
- ☐ Syringes (various sizes)
- ☐ Skin marker
- ☐ Gauze pads (2x2, 4x4)/Washcloths
- ☐ Glucometer
- ☐ Medical tape
- ☐ Urine test trips
- ☐ Saline flushes

APPENDIX E: RECOMMEND NURSING SKILLS CHECKLIST FOR CLINICAL ROTATION

- ☐ Perform and document physical exam
- ☐ Perform vital sign monitoring
- ☐ Radial, DP/PT pulse check: manually/Doppler probe
- ☐ Perform finger stick blood sugar
- ☐ Perform phlebotomy
- ☐ Manually titrate IV fluid drip rates
- ☐ Monitor hourly urine output
- ☐ Perform US dipstick
- ☐ Measure gastric residual
- ☐ Insert Foley; perform Foley care
- ☐ Flush PRN IV locks
- ☐ Start peripheral IV
- ☐ Administer IV/oral medications
- ☐ Monitor GCS/pain (1 – 10 or nonverbal pain scale)/sedation levels (RASS scale)
- ☐ Effectively titrate analgesics
- ☐ Effectively titrate sedatives/daily wake up for neuro evaluation
- ☐ Insert OG/NG tube
- ☐ Perform Cric (Trach) care
- ☐ Endotracheal suctioning
- ☐ Perform oral suctioning
- ☐ Perform nasal care
- ☐ Perform oral care
- ☐ Apply lip balm
- ☐ Apply eye ointment/drops
- ☐ Brush teeth
- ☐ Change all tape
- ☐ Adjust ventilator settings: understand FiO2, TV, PS, PEEP, etc.
- ☐ Auscultate lungs
- ☐ Measure compartment pressures (extremities, abdominal)
- ☐ Perform wound care (trauma, burn)
- ☐ Irrigate wounds
- ☐ Debride wounds
- ☐ Auscultate and palpate abdomen
- ☐ Provide appropriate nutrition
- ☐ Perform escharotomy (animal lab, simulation)
- ☐ Insert IO (simulation: sternum, humerus, tibia)
- ☐ Perform neuro exam
- ☐ Calculate total burn size (Rule of nines, Lund-Brower)
- ☐ Calculate burn resuscitation: starting volume (Rule of 10's), total volume (Ivy Index)
- ☐ Titrate burn resuscitation fluid to meet target urine output
- ☐ Perform ultrasound FAST exam
- ☐ Perform blood typing using Eldon Card
- ☐ Perform blood donor screening procedure
- ☐ Reduce/splint fractures (Simulation)
- ☐ Convert tourniquet (Simulation)

APPENDIX F: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Nutritional Support Using Enteral and Parenteral Methods (CPG ID: 33)

How to achieve optimal nutritional support for the critically injured or ill patient using enteral nutrition and parenteral nutrition methods.

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PURPOSE

- To define an approach to optimal nutritional support in the critically ill or injured patient.
- To establish meaningful goals for implementing enteral nutrition.
- To provide an understanding of the various formulations for enteral nutrition and their use.
- To establish the indications for total parenteral nutrition.

DEFINITIONS

- **Enteral Nutrition (EN):** The use of the stomach, duodenum, or jejunum to provide the nutrition targets to optimize healing and normal physiologic function.
- **Total Parenteral Nutrition (TPN):** Formulated nutritional substrate provided intravenously to optimize healing and normal physiologic function.

GUIDELINES

1. Consult medical nutrition therapy on all ICU patients for nutritional assessment and cooperative guidance on nutritional support.
2. Consider tele-consultation to next level of care if Medical Nutrition Therapy services are not available locally.
3. Enteral nutrition should be the first choice over total parenteral nutrition for the patients unable to consume food on their own. Enteral nutrition maintains gut mucosal integrity and immunocompetence.
4. When compared to parenteral nutrition, EN in appropriately selected patients has been associated with a decrease in infectious complications, decreased hospital length of stay and a significant reduction in ICU length of stay
5. It is important to note that the maximal benefit of enteral nutrition is obtained when it is started early (within 48 hours of admission) and that the benefit does not appear to be dose-dependent, so even low-rate (trickle) feeding can improve outcomes.[1,2]

ENTERAL NUTRITION

INDICATIONS FOR ENTERAL NUTRITION

1. Any patient on the trauma service who is anticipated to remain unable to take full oral intake on their own for greater than 5-7 days.
2. Any patient who has oral intake with supplementation that is inadequate to meet current nutritional needs (i.e., < 50% of estimated required calories for >3 days.)
3. Any patient with pre-existing malnutrition (>15% involuntary weight loss or pre-injury albumin < 3 g/dl) or categorized as “high nutritional risk” based on a validated nutritional risk scoring system and unable to immediately resume full oral intake. It should be emphasized that for albumin to be useful as a nutrition maker, it should be obtained prior to injury. However, in the combat trauma setting, a pre-injury albumin level is unlikely to be available. Further, albumin measured during acute illness should not be used or followed as a marker of nutrition as it is an acute phase reactant and will markedly

decrease during the initial period of critical illness. An initial pre-albumin level is also less useful immediately after injury, but serial pre-albumin levels can be useful during the resolution and recovery phase. If utilized pre-albumin should not be checked more frequently than once weekly.[1-4]

ABSOLUTE CONTRAINDICATIONS FOR ENTERAL NUTRITION

1. High risk for non-occlusive bowel necrosis
   - Active shock or ongoing resuscitation
   - Persistent mean arterial pressure (MAP) < 60mmHg
   - Increasing requirement for vasoactive support to maintain MAP>60mmHg
2. Generalized peritonitis
3. Intestinal obstruction
4. Surgical discontinuity of bowel
5. Paralytic ileus
6. Intractable vomiting/diarrhea refractory to medical management
7. Known or suspected mesenteric ischemia
8. Major gastrointestinal bleed
9. High output uncontrolled fistula [1-3]

RELATIVE CONTRAINDICATIONS FOR ENTERAL NUTRITION

- Body temperature < 96 F
- Concern for abdominal compartment syndrome as evidenced by bladder pressure > 25mmHg [1-3]

PARENTERAL NUTRITION

INDICATIONS FOR PARENTERAL NUTRITION

1. Unable to meet > 50% caloric needs through an enteral route by post-injury day #7
2. Any of the contraindications for enteral nutrition listed in above that persist and patient is without nutritional support for 3 days or patient is not anticipated to start enteral nutrition for more than 3-5 days.
3. Massive small bowel resection refractory to enteral feeds.
4. High output fistula after failure of elemental diet.
5. Any patient with pre-existing malnutrition (>15% involuntary weight loss or pre-injury albumin < 3 g/dl) or categorized as “high nutritional risk” based on a validated nutritional risk scoring system (NUTRIC or other) and with contraindication or intolerance to enteral feeding. [1-4]

ENTERAL ACCESS

1. Enteral access will be established ideally within 24 hours of admission to the Role 3 or higher Medical Treatment Facility (MTF).[1-3,5,6]
2. If the patient will be taken to the operating room within 24-48 hours of arrival for laparotomy procedure, a naso-jejunal feeding tube (NJFT) should be placed while the patient is in the operating room (OR). While in the civilian setting in intubated patients there is no difference in outcomes when comparing EN via the naso-jejunal versus gastric route, however enteral access distal to the stomach is recommended, particularly in those patients at risk for aspiration. Due to the intermittent nature of gastric feedings and the need for frequent holdings for patient aeromedical evacuation and/or procedures in the combat environment, it is emphasized that this is NOT the preferred initial method of feeding these patients. However if this is not practical, in many patients it is acceptable to initiate gastric EN. [1,3]
3. If the patient is not a candidate for operative placement, use whatever means available to place a feeding tube. (e.g., endoscopic, fluoroscopic, etc.).
4. If unable to place a NJFT, consider the use of an Oro-Gastric (OG) or Naso-Gastric (NG) tube, with intent to discontinue enteral feeds 6 hours prior to transfer.
5. If prolonged enteral feeding (>4 weeks) is expected, then placement of a surgical feeding tube should be considered. A gastrostomy, jejunostomy, or combined gastro-jejunostomy should be considered prior to final closure of any open abdomen patient, and the risks versus benefits of each option along with the existing patient gastrointestinal anatomy will dictate the choice of surgical feeding access. [1-6]

NUTRITIONAL ENERGY/PROTEIN REQUIREMENTS

Nutritional energy/protein requirements are based on the patient's current nutritional status and severity/type of trauma suffered. The previous practices of over-feeding critically ill or injured patients by multiplying a calculated caloric goal by some "stress factor", or increasing caloric intake above the goals calculated per the below guidelines, should NOT be applied to the ICU patient. This is associated with no nutritional benefit but a significant increase in the risk of adverse events and complications associated with overfeeding. [1, 2] Table 1 lists some basic guidelines and Table 2 lists vitamin and mineral supplementation recommendations.[1-3]

Table 1. Enteral Feeding Calculations	
Body Mass Index (BMI)	(wt in kg) / (ht in m)^2
Ideal Body Weight (IBW)	Male: (50kg) + (2.3kg per inch over 5ft) Female: (45.5kg) + (2.3kg per inch over 5ft)
Kcal	High Stress Trauma/Burn: 25-35 kcal/kg/day dry wt
	Vent (>72 hours) or ARDS: 20-25 kcal/kg/day dry wt
	Obese (BMI>30): 22-25 kcal IBW or 11-14 kcal/day actual wt
Protein	Major Trauma/Burn/TBI: 1.5-2.0 g/kg/day *Large Burn may need up to 1.5-2.0 g/kg/day
	Obese (BMI>30): 2g/kg/day IBW
	Most patients: 1.2-1.5 g/kg/day
Fat	15-30% of kcal
	15-20% of kcal in major burns
Free Water	1ml/kcal

Table 2. Vitamin and Trace Mineral Supplementation	
Continue for 7 days and then re-assess patient's clinical and nutritional condition. [1,18-20]	
**Closely Evaluate Dosing in Renal and liver Failure patients.	
Vitamin C	500 mg IV daily if CrCl<30ml/hour Note: Higher doses of Vitamin C may increase or contribute to diarrhea
Zinc Sulfate	220 mg tab by mouth once a day for no more than two weeks
Vitamin E	1000-1200 IU PO/OG/NG/NJFT every eight hours
Selenium	200 mcg IV or PO/OG/NG every 24 hours
Multivitamin Tab, Elixir, or IV once a day	Prenatal vitamins are often an excellent choice for supplementation if iron is also needed. For those unable to swallow a large pill or for whom the iron causes GI upset, children's chewable vitamins are well tolerated.

SPECIAL CONSIDERATIONS

Use caution when evaluating the injured active duty population. Many are young, healthy, and very muscular. If they are muscular with a BMI > 30, you should use their estimated actual weight pre-injury. Those with a BMI > 30 due to obesity should use the IBW when indicated as stated above. Pick any of the above formulas you like as they are all 70–80% accurate compared to a metabolic cart study, which is not available until the patient reaches the U.S. and should be used as soon as possible to obtain the gold standard for caloric and macronutrient requirements.

ROLE OF HYPOCALORIC FEEDING

Although 25-35 kcal/kg/day has been widely utilized as a caloric target when feeding critically ill patients, there has been a growing body of literature that suggests that permissive underfeeding with lower caloric targets is as effective as higher calorie targets and may decrease morbidity from overfeeding or from other adverse effects of delivering a full nutritional load to a metabolically stressed patient. There have been several recently published randomized trials (EDEN and PERMIT)[8-10] in mixed critically ill patients and in surgical patients only 11 that have shown equivalent primary outcomes with hypocaloric (10 kcal/kg/day) feeding versus normocaloric (25-35 kcal/kg/day). However, a meta-analysis suggests improvement in some secondary outcome measures with the hypocaloric approach.[12] Currently, a hypocaloric approach is a reasonable alternative in patients with low or intermediate nutritional risk (based on NUTRIC or other scoring system) and no pre-existing malnutrition, and may decrease select complications such as feeding intolerance, diarrhea, and high gastric residual volumes. Further, hypocaloric feeding (10-20 kcal/kg) has also been found to have multiple benefits in patients with pre-existing obesity (BMI>30) by reducing excessive fat stores while simultaneously preserving lean body mass. However, it is critical when using a hypocaloric approach in ANY patient to understand than "hypocaloric" refers to non-protein calories, and that it must always be accompanied by full and adequate protein delivery (typically 1.5 to 2 grams/kg ideal body weight).[1,2]

FORMULA SELECTION

1. High protein, volume concentrated formula (e.g., IMPACT® or equivalent). A formula with fiber would be contraindicated in patients who are at risk for bowel ischemia or are hemodynamically unstable. [1-3]

Use for:

- Major trauma patients for the first 7 days of nutrition support.
- Moderately malnourished patients undergoing major elective procedures of the esophagus, stomach, pancreas, hepatobiliary tree or abdominal-perineal resection

- Severely malnourished patients (pre-albumin < 10gm/dl) undergoing large bowel resection.
- Prolonged starvation > 6 days.
- High output distal small bowel fistula (>500 mL output).
- Burn patients.

2. Semi-elemental/elemental enteral formulas (may contain some fiber, moderate protein, and may be supplemented with Omega-3 fatty acids and/or probiotics). Semi-elemental and elemental formulas allow for ease of digestion/absorption. (E.g., Vital®, Vital 1.2 AF®, Vital 1.5®, Peptamen®, Peptamen 1.5®, Peptamen AF® are semi-elemental; Vivonex®, Vital HN®). Use for:
   - Proven intolerance to the first formula used
   - Persistent, severe diarrhea > 48hrs
   - Pancreatic or duodenal injury
   - Moderate distention > 24hrs
   - Short bowel syndrome
   - At discretion of attending physician
3. Polymeric, fiber free formula (E.g., Osmolite®1.0, 1.2, 1.5; Nutren® 1.0, 1.5,)—isotonic enteral feed with long-chain proteins, carbohydrates and a normal fat content. Use for:
   - Patients with a moderate protein need, normal digestive and absorptive capacity of the GI tract.
4. Polymeric with mixed fiber formula (Jevity 1.0, 1.2, 1.5, Fibersource HN, Nutren 1.0 Fiber, Nutrisource Fiber) added fiber content to promote more formed stool. Use for:
   - Stable, long term patients and those requiring a bowel regimen (e.g., paraplegics)
5. Other formulas include:
   - Isosource 1.5—high protein, high calorie, fiber containing formula with 1.5 kcal/ml to limit volume.
   - Nepro— volume concentrated (1.8 kcal/mL), lower in K+, Mg, Phos therapeutic nutrition with mixed fiber for patients on dialysis
   - Promote, Replete: High protein, polymeric formula, 1.0 kcal/mL. Appropriate for use in patients who tolerate a standard formula but require additional protein and do not need a volume concentrated product.
6. Additional fiber source: Use if additional fiber is needed for stool management, use the soluble variety (e.g., Nutrisource Fiber ® or equivalent.)
7. Additional protein source: Use if additional protein is needed when calorie needs are already being met by the enteral formula (ex: Beneprotein®, ProMod®, ProStat®). Content of protein varies depending on protein source used.

ENTERAL NUTRITION INITIATION AND ADVANCEMENT

VOLUME-BASED AND TOP-DOWN FEEDING PROTOCOLS

Among the many challenges to the delivery of a “goal” dose of enteral calories is the cessation of tube-feeding for procedures, patient “intolerance,” tube dislodgment, diarrhea, transfers, imaging, or other common ICU events. Improved delivery of total caloric goals has consistently been demonstrated through the use of a protocolized approach that aims to minimize interruptions and to empower the bedside caregiver (ICU nurse) to

make adjustments to ensure that caloric goals are met. A "volume-based" protocol targets a daily volume of enteral feeding rather than an hourly rate, and allows adjustments in the infusion rate or additional boluses to make up for volume lost when enteral feeds are held or interrupted.[1] When initiating and advancing enteral nutrition the following is recommended:

1. Start enteral tube feed with full strength formula at 20 ml/hour.
2. Increase rate by 20 ml/hour every 6-8 hours to goal rate if low risk for intolerance
3. If high risk for enteral feed intolerance, open abdomen, or known severe ileus, maintain trophic rate (20-30 ml/hr) for first 24 hours, then advance if well tolerated.
4. For BURN and HEAD injured patients with no abdominal trauma or other contraindications, advance 20 ml every 4 hours to goal rate.

NOTE: *When a patient is transferred from one level of care to the next in a rapid fashion (e.g., Forward Operating Base (FOB) to Role 3 to Role 4 (e.g., Landstuhl Regional Medical Center (LRMC)), it is difficult to monitor feeding tolerance during AE or Critical Care Air Transport Team (CCATT) evacuation. It may be best to hold initiation of feeds until patient will be at one location for at least 24 hours. The risk of aspiration in an awake patient or intolerance in an intubated patient is real and necessitates appropriate repeated examinations until feeding tolerance is well established prior to any flights.*

GLUTAMINE

In general, glutamine supplementation should not be utilized in the critically ill, including the critically ill combat trauma patient. This represents a major change from the previous CPG.[3] Rationale in favor of glutamine supplementation includes that critically ill patients often have decreased glutamine levels upon ICU admission, low plasma glutamine is associated with increased mortality and there are data to suggest that glutamine supplementation may reduce infections complications.[1,2,13-15] However, recent evidence indicates that glutamine supplementation significantly increases mortality rates in the critically ill, and particularly those with significant organ dysfunction syndromes.[14-16] The role of glutamine supplementation in trauma and burn patients is less clear. Available evidence regarding the benefits of glutamine supplementation in trauma patients is conflicting and a recent meta-analysis regarding enteral glutamine supplementation in trauma patients found no mortality benefit, and a trend towards decreased infectious morbidity.[16] We recommend against enteral or parenteral glutamine supplementation in critically ill combat trauma patients. The only population in which glutamine supplementation should be considered is the patient with isolated burn injury and no evidence of sepsis or multiple organ dysfunction.[1,16,17] Results of a large multi-center randomized trial (RE-ENERGIZE) are pending and will further guide the use of glutamine supplementation in the burn population once they are available.

ENTERAL SUPPLEMENTATION FOR THOSE PATIENTS TOLERATING A DIET

Many traumatically injured patients can tolerate a regular diet. For various reasons, however, patients may be subjected to frequent holding of oral intake for procedures, recovery periods after procedures, decreased appetite due to medications, etc. Supplementation drinks when a patient is eating can help bridge some of the caloric deficits and provide nutritional therapeutic benefits missed during the time-limited periods of inadequate intake.

- Recommended high-protein drinks (e.g., Ensure Plus®, Boost Plus®, Impact© Advanced Recovery™, or equivalent) can be administrated at 0.5–1.0 L per day (2–4 drinks) in addition to meals.

- There is no evidence of benefit of routine enteral supplementation in nutritionally low risk patients with intermittent brief (<48 hours) periods of NPO status.
- For moderate and high nutritional risk patients or pre-existing malnutrition, supplemental oral nutritional intake between NPO periods should be maximized and TPN considered if oral intake is inadequate or evidence of worsening nutritional parameters (e.g., weight loss, decline in pre-albumin, muscle loss).

GENERAL CONSIDERATIONS (GASTRIC FEEDS)

General considerations for patients receiving gastric feeds[1]:

1. Gastric feeds may be necessary to initiate early enteral nutrition but are highly discouraged in the combat trauma patient population during the period of rapid transport to CONUS.
2. If the clinical scenario warrants consideration of gastric feeding, it must be discussed with the attending trauma surgeon and coordinated among the entire multidisciplinary team.
3. Use of pro-kinetic agents to maximize tolerance to enteral feeding should be attempted before cessation of enteral feeding.
4. Gastric residual volumes (GRV) may be utilized, but feeding should not be halted for GRV of less than 500 cc.

GENERAL CONSIDERATIONS (JEJUNAL FEED)

General considerations for patients receiving enteral nutrition into the jejunum:

1. Maintain head of bed > 30 degrees at all times or in reverse Trendelenburg position if spine not cleared.
2. Obtain portable abdominal X-ray within12 hours of any aeromedical movement or transfer to confirm feeding tube location is within jejunum.
3. Enteral nutrition administered into the jejunum (past the ligament of Treitz) does NOT need to be stopped prior to going to the operating room, diagnostic tests, CCATT/AE transport, lying flat for procedures, etc.
4. Keep OG tube on intermittent low wall suction while initiating and advancing tube feeds via NJFT.

NJFT MAINTENANCE

1. Due to the size (8-12F) of the NJFTs, meticulous care is needed to prevent clogging of tubes. This is easily managed by flushing the tubes every 2 hours, and BEFORE and AFTER all medications given.
2. Clogging is due to either lining of the NJFT with a build-up of tube feeds or inappropriate medications given down the tube.
3. The volume of the tube is so small that no amount of pancreatic enzymes, bicarbonate, cola, etc. is effective to maintain patency for any extended period of time. Prevention of the buildup is essential to ensure a functioning tube.
4. Recommend flush feeding tube with 20 ml water (may also use pre-filled NS syringes) every two hours. Flush an additional 20 ml BEFORE and AFTER all medications are given. The volume may be increased if patient's condition and fluid requirements dictate.

5. For patients who are estimated to require prolonged enteral feeding (>4 weeks) or who are unable to tolerate or maintain a nasoenteric tube, placement of a surgical feeding tube is strongly encouraged if no absolute contraindication is present. For patients requiring prolonged enteral feeding access a gastrostomy tube is preferred over a jejunostomy for ease of management, routine care, and conversion to a simplified bolus tube-feeding regimen.

GENERAL CONSIDERATIONS (PARENTERAL NUTRITION)

1. TPN is generally unavailable in a combat zone.
2. Only utilize TPN when enteral nutrition is not possible or is inadequate to meet the minimal estimated caloric requirements.[1]
3. General initial TPN orders: 20-25 kcals/kg. Initial Dextrose of 150 g if diabetic, 200 g if not diabetic. Increase by 50 g/day if good glycemic control. Glucose infusion rate of 2-3 mg/kg/min initially. IV-Lipids of no more than 1 g/kg/d. Hold IV lipids if TG > 400 mg/dL. Provide trace elements only 1-2x/wk if total bilirubin is > 4 mg/dL.
4. Ensure patient has a clean, dedicated central line or peripherally-inserted central catheter (PICC) for administration of TPN.
5. A 0.2 micron in-line filter should be used with non-lipid containing TPN, and a 1.2 micron filter used with any lipid-containing TPN.

MEDICATION CONSIDERATIONS

INOTROPIC AGENTS (E.G., DOBUTAMINE, MILRINONE)

No change to feeding plan recommended. Advance per feeding protocol.

PARALYTICS, VASOACTIVE AGENTS

(Includes but not limited to: e.g., vasopressin > 0.04 units/min, dopamine > 10 mcg/kg/min, norepinephrine > 5 mcg/min, phenylephrine > 50mcg/min, any epinephrine)

1. Elemental formula at 20 ml/hr – do not advance.
2. Consider TPN starting post injury day number 7 if enteral feeds are not tolerated or not tolerated at the goal rate.
3. Consider early initiation of TPN in high nutritional risk score or pre-existing malnutrition patients.
4. Hold enteral feeding if adding vasopressor, increasing dosages of vasopressors, or persistent MAP < 60 mmHg.

LABORATORY EVALUATION

1. Obtain a pre-albumin every Monday for those with ICU stays greater than 7 days.
2. Obtain liver function tests (LFTs) and lipid panels at baseline and every Monday for those on TPN.

ENTERAL NUTRITION INTOLERANCE MANAGEMENT

(See Appendix A)

VOMITING

1. If no OG/NG tube in position, place one and initiate low wall suction.
2. Check existing OG/NG tube function and placement location.
3. If OG/NG tube is in proper position and functional, decrease tube feed rate by 50% and notify physician for further evaluation and work up.
4. Ensure patient is having normal bowel elimination.
5. If the patient is receiving gastric enteral feeding, consider placing the feeding tube post-pyloric.

ABDOMINAL DISTENSION (MILD TO MODERATE)

1. Perform history and physical exam.
2. Maintain current tube feed rate and do not advance.
3. Obtain portable abdominal x-ray to assess for small bowel obstruction or ileus.
4. Ensure patient is on bowel regimen to avoid constipation.
5. If distention persists >24hrs with no contraindication for continued tube feeds, switch to elemental formula.
6. If feeding while the patient is on low-dose vasopressors, any increase in distention should prompt holding tube feeds and consideration of bowel ischemia.

SEVERE

1. Perform history and physical exam.
2. Stop tube feed infusion.
3. Monitor fluid status.
4. Consider workup—CBC, lactate, ABG, Chem7, KUB, CT scan abdomen.
5. Check bladder pressure.

DIARRHEA

1. If the patient develops Moderate (3–4 times/24 hrs or 400–600ml/24hrs) to severe diarrhea (>4 times/24hrs or > 600ml/24hrs) consider the following:
2. Review medication record for possible causes of new onset diarrhea.
3. Obtain abdominal x-ray to evaluate feeding tube location.
4. Consider working up patient for Clostridium difficile (C. diff.) infection. If evidence of C. diff. infection, treat with oral metronidazole or oral Vancomycin depending on severity. If utilized, antidiarrheal

medications should be administered with great caution in the patient with C. diff. and should only be considered in the patient with a controlled or improving C. diff. infection.

5. Monitor fluid and electrolyte status.
6. Consider starting a soluble fiber supplement (e.g., guar gum, provide 1 pkg BID, increase to 1 pkg QID if stool consistency does not improve in 2-3 days).
7. If there is no evidence of C. diff. infection, consider giving 2 mg loperamide after each loose stool. An alternative is codeine 15 mg.

HIGH OG/NG TUBE OUTPUT

(> 1200 ml/24 hrs) with OG/NG tube to continuous suction and feeding via NJFT.

1. Stop tube feeds.
2. Obtain abdominal x-ray to determine location of OG/NG tube and NJFT.
    a. Verify OG/NG tube is in the stomach. If tube is past pylorus, pull it back into stomach and resume tube feeds at previous rate.
    b. Verify NJFT is in correct position. If NJFT is in the stomach take appropriate action to move the tube to the appropriate position. If NJFT is in the correct position, decrease tube feeds by 50% and assess patient's overall condition.
3. Check NG/OG tube aspirate for glucose testing in lab.
    c. If glucose > 110, hold tube feeds for 12 hours and re-evaluate.
    d. If glucose negative, resume tube feeds at 50% previous rate.

INCREASED GASTRIC RESIDUAL VOLUMES (GRV)

(With gastric or post-pyloric feeding)

1. If feeding through OG/NG tube, or if additional OG/NG tube in place (NJFT or post-pyloric feeding tube) check gastric residuals every 4-8 hours.
2. Ensure no evidence of new ileus (i.e. lack of bowel regimen, electrolyte abnormalities, recent abdominal operation, abdominal compartment syndrome, C. diff infection etc.) or bowel obstruction.
3. Re-infuse the entire gastric aspirate or administer an equivalent volume of ½ normal saline.
4. If GRV > 300 ml on two consecutive checks, notify physician.
5. Start Erythromycin 250 mg IV or oral every 6 hours or metoclopramide 10 mg IV every 6 hours and continue every 4 hour residual checks.
6. Hold enteral feeds only when ordered by physician.

BOWEL REGIMEN

Those patients at high risk for acute constipation should be started on a bowel regimen. If a patient is receiving tube feeds and has less than one Bowel Movement (BM) every two days, they should be started on the bowel care protocol. A bowel care protocol also may be started empirically with initiation of enteral nutrition in patients know to be at risk for constipation.

ACUTE CONSTIPATION

Inclusion criteria for patients at high risk for acute constipation:

- Opioids
- Immobility
- Altered diet and fluid intake
- Stress
- History of constipation

RELATIVE CONTRAINDICATIONS

- Rectal surgery
- Abdominal pain
- Allergy to bowel regimen medications
- Neutropenia (ANC < 1000/mm^3)
- Thrombocytopenia (platelets < 30,000)

ABSOLUTE CONTRAINDICATIONS

Suspected or confirmed bowel obstruction

NOTE: *If patient has had one BM every two days, patient is at Stage One or under observation only.*

STAGE ONE

(If no bowel movement for 48 hours)

Patient assessment and rectal exam

1. Impacted: Manually dis-impact; give soap suds enema once OR Bisacodyl 10 mg suppository once daily
2. Not impacted: Docusate 100 mg PO or NJFT q 8 hours and Senna 1 tab PO or 5ml via NJFT every am
3. If no BM or very small amounts in 24 hours following initiation of Stage One, proceed to Stage Two.

STAGE TWO

1. Add Bisacodyl 10 mg supp once daily, hold if stooling and continue with Stage One regimen.
2. If no BM or very small amounts within 24 hours, proceed to Stage Three.
3. If patient develops loose stools or diarrhea, return to Stage One.

STAGE THREE

1. Add Milk of Magnesia 30 ml PO every 6 hours or Miralax 17 grams PO/NJFT twice daily until BM, then stop (avoid Milk of Magnesia if renal insufficiency is present). Return to Stage Two.
2. If no BM in 24 hours or very small amounts, proceed to Stage Four.
3. If patient develops loose stools or diarrhea, return to Stage One.

STAGE FOUR

1. Call and notify MD.
2. Obtain an abdominal x-ray.
3. Clarify continued therapy for bowel care.

FECAL MANAGEMENT SYSTEM

For patients requiring the use of Fecal Management System (FMS) for wound care and/or stool management, please refer to manufacturer's instructions for use. FMS should only be used with the approval of the patient's attending surgeon.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All ICU patients

INTENT (EXPECTED OUTCOMES)

Enteral feeding access is established or oral diet initiated within 24 hours of admission to the Role 3 or higher Medical Treatment Facility (or contraindication documented).

PERFORMANCE/ADHERENCE METRICS

Number and percentage of patients in the population of interest who have enteral access established or oral diet initiated within 24 hours of admission to the Role 3 or higher Medical Treatment Facility.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.
The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: ADULT PARENTERAL NUTRITION ORDER FORM

DIRECTIONS: The provider will DATE, TIME, and SIGN each order or set of orders recorded. Only one order is allowed per line. Nursing will list the time the new order(s) are noted and initial in the column provided. Orders completed during the shift in which they were written do not require recopying. They may be signed off, as completed, in the far right column.

ORDER NUMBER	PROVIDER: DATE, TIME, & SIGN EACH PAGE OF ORDERS
	ADULT PARENTERAL NUTRITION ORDER FORM

Date:	Time:	Service:	Allergies:

Check and complete appropriate orders, where indicated. All order amounts are PER 24 HOURS

1. Access Route: ☐ Central ☐ Peripheral (must be less than 900 mOsm/liter; intended for short term use only)

2. Rate of Infusion: ☐ Infuse over 24 hours (rate determined by pharmacy, based on final volume
☐ Cyclic Infuse from _____ to _____

3. Base Formula:

Nutrients	Total Volume	Amino Acids	Dextrose (Carbohydrate, CHO)
☐ Premix Central Formula withOUT electrolytes	1000 mL	8.5% 500 mL (42.5 grams protein)	50% 500 mL (250 grams dextrose)
☐ Custom Parenteral Formulation	_____mL (not include lipids)	Please use 500 mL increments, where clinically appropriate ☐ 8.5% _____mL (42.5 grams protein/ 500 mL) ☐ 10% _____mL (50 grams protein/ 500 mL) ☐ 15% _____mL (75 grams protein/ 500 mL)	☐ 25% _____mL (125 grams dextrose/ 500 mL) ☐ 50% _____mL (125 grams dextrose/ 500 mL) ☐ 70% _____mL (125 grams dextrose/ 500 mL)

4. Lipids: 20% fat emulsion (2 kcal/mL) ☐ 500 mL ☐ 250 mL Infuse IV over 12 hours ☐ every day ☐ every __days

5. Electrolytes and Additives (per 24 hr bag)

Standard Electrolyte Package		Customized Electrolytes	Additives (per 24 hr bag)
Sodium 35mEq Potassium 20 mEq, Chloride 35mEq Acetate 29.5meq Magnesium 5 mEq Calcium 4.5mEq (Hospira TPN Lytes 20 mL) *Does not contain phosphate*	_____ packages (usual 1-2/day)	Sodium chloride _____mEq Sodium acetate _____mEq Potassium chloride _____mEq Potassium acetate _____mEq Sodium phosphate _____mMol Potassium phosphate _____mMol Magnesium sulfate _____mEq Calcium Gluconate _____mEq	☐ Trace Elements 1 mL ☐ Multi-Vitamins 10 mL ☐ Ascorbic acid _____ mg ☐ Ranitidine _____mg ☐ Insulin _____units ☐ On an insulin infusion ☐ Phytonadione 10mg every Monday ☐ Other: _____

NOTE: *Maximum calcium:phosphate ratio = 50 (see reverse for calculation)*

6. Additional Orders

a. Labs
- ☐ Baseline: basic metabolic panel (BMP), albumin, liver function panel (if not done in last 24 hours)
- ☐ Daily: BMP; Every other day: Calcium, magnesium, phosphate
- ☐ Weekly: albumin, triglycerides
- ☐ Blood glucose (BG) every 6 hours; discontinue if BG < 150 x 4; call MD for >150 for two sequential checks if not ordered for insulin

b. For initial order (first bag): Please notify dietician and pharmacist, to complete patient assessment.

c. Strict I/O's, daily weight

d. Infuse total parenteral nutrition (TPN) thru a dedicated line.

e. Use an in-line filter (0.2 micron filter for non lipid containing and 1.2 micron filter for lipid containing TPN)

f. For discontinuation of the TPN, cut the rate by 50% for 60 minutes, then stop (to prevent hypoglycemia)

PATIENT IDENTIFICATION	Signature Date/Time (Printed Name)

LRMC ADULT PARENTERAL NUTRITION ORDER FORM	Nursing Unit	Room No.	Bed No.	Page No. 1

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GUIDELINES FOR ORDERING ADULT PARENTERAL NUTRITION

SUBSTRATES	KCAL SUPPLIED	COMMENTS
DEXTROSE (Carbohydrate/CHO)	3.4 kcal/one gram dextrose	CHO tolerance ranges from 2-5 mg/kg/minute. Maximum CHO utilization/tolerance average is 4 mg/kg/minute: 4 x (weight in kg) x 1.44 = grams CHO/day
AMINO ACIDS (Protein/AA)	4.0 kcal/one gram protein	6.25 gm protein per 1 gm Nitrogen. Dosage depends on degree of stress/injury, renal/liver function
LIPID (Fat)	9.0 kcal/ one gram fat (20% = 2.0 kcal/mL) (Propofol = 1.1 kcal/mL)	Not to exceed 30% of total kcals or 0.8 grams fat/kg

ADDITIVES

Electrolytes	Normal Range of Daily Requirements	Recommended Maximum per Liter
Calcium*	10-15 mEq/day (5 mEq/liter)	(up to) 10 mEq (when combined with P)
Magnesium	8-24 mEq/day (5 mEq/liter)	(up to) 15 mEq
Potassium	90-240 mEq/day (20-50 mEq/liter)	(up to) 80 mEq
Sodium	60-150 mEq/day (20-50 mEq/liter)	Wide Range
Acetate	80-120 mEq/day (30-50 mEq/liter)	Wide Range
Chloride	60-150 mEq/day (20-50 mEq/liter)	Wide Range
Phosphorus**	30-50 mMol/day (10-15 mMol/liter)	(up to) 30 mMol (when combined with Ca)

*Calcium gluconate provides approximately 5 mEq Ca/gram

**Potassium phosphate provides 0.68 mMol phosphate/1 mEq K; sodium phosphate provides 0.75 mMol phosphate/1 mEq Na

Vitamins:	One Multi-Vitamin package (10 mL) provides the following:		
	Retinol (A) 3300 units (1 mg) Ergocalciferol (D) 200 units(5 mcg) Tocopherol (E) 10 units (10 mcg) Phytonadione (K) 150 mcg	Ascorbic Acid 200 mg Riboflavin (B2) 3.6 mg Thiamine (B1) 6 mg Pyridoxine (B6) 6 mg Pantothenic acid 15mg Biotin 60 mcg	Folic acid 600 mcg Cyanocobalamin (B12) 5 mcg Niacinamide 40 mg
Trace Elements:	One dose of 1 mL should be administered daily except with renal failure and/or liver dysfunction.		
	One trace minerals package provides the following:		
	Zinc 5 mg ** Copper 1 mg Manganese 0.5 mg Chromium 10 mcg		
	Additional supplementation of trace elements may be required based upon degree of stress, injury or disease state		
	*Additional 2.0 mg Zinc/day in acute catabolism; 12.2 mg/L small bowel fluid losses; 17 mg/kg stool or ileostomy output		
	Selenium should be supplemented with long-term parenteral nutrition (60 micrograms/day).		
Regular Insulin:	It is reccommended that insulin be provided on a sliding scale requirement or by an insulin drip. If added to parentral nutrition orders, it should be in amounts no less than 10 units per liter and only to the nearest 5 or 10 units per liter.		
Calcium:	**Phosphate calculation** Ca^{+2} in each liter (mEq) + [2 x PO_4 in each liter (mMol)] must be less than or equal to 50, to prevent precipitation of $CaPO_4$		

GENERAL REQUIREMENTS

Kcals:	25-35 kcal/kg dry weight 25-30 kcal/kg dry weight for ventilated pts	
Protein:	1.0-1.5 grams protein/kg 1.5-2.0 grams protein/kg in trauma/head injury In obese pts: use IBW to calculate protein needs	
Fluid:	30-35 mL/kg	

OSMOLARITY (mOsm) for PPN

CHO	mOsm/L	Protein	mOsm/L	Fat	mOsm/L
$D_{10}W$	505	AA 8.5%	890	20% lipids	260
$D_{20}W$	1010	AA 10%	1000		
$D_{30}W$	1515	AA 15%	1500		
Maximum recommended mOsm for PPN = 900mOsm/liter (maximum example: D20W 500 mL and AA 8.5% 500 mL)					

APPENDIX B: ENTERAL NUTRITION POCKET REFERENCE GUIDE

FORMULA SELECTION

Critical Care enteral formulas
(High protein/volume concentrated, may contain immunonutrients)

1. Patients sustaining major trauma receive immune-enhancing diet for 10 days (except BURN patients):
2. Non-trauma patients who the attending surgeon believes to be at risk for major septic morbidity, such as:
   - Moderately malnourished patients) undergoing major elective procedures of the esophagus, stomach, pancreas (with or without duodenum), hepatobiliary tree or abdominal-perineal resection.
   - Severely malnourished patients, or undergoing colonic resection
3. Prolonged starvation > 5 days
4. High output distal colonic fistula

Elemental Formulas
Patients who have:

1. Proven intolerance to the first formula used
2. Persistent, severe diarrhea > 48hrs
3. Pancreatic or duodenal injury
4. Moderate distention > 24hrs
5. Short bowel syndrome
6. At the discretion of the attending physician.

Polymeric Formula
Patients who do not meet the criteria for immune-enhancing diets but have normal digestive and absorptive capacity of the GI tract

TOTAL PARENTERAL NUTRITION
Indications include:

- Massive small bowel resection refractory to enteral feeds
- High output fistula after failure of elemental diet
- Unable to meet >60% needs enterally by day ICU day #5

FEEDING PROTOCOL

After resuscitation complete, start full strength formula at 20 ml/hr advance as follows:

- Increase by 20 ml/hr every 8 hours until the targeted goal is reached.
- In burn/head trauma patients with no abdominal injury, increase every 4 hours until the targeted goal is reached.
- Do not stop enteral feedings for procedures to include trips to OR, CT scanner or AE (for tubes inserted beyond the ligament of Treitz).

ENERGY/PROTEIN REQUIREMENTS

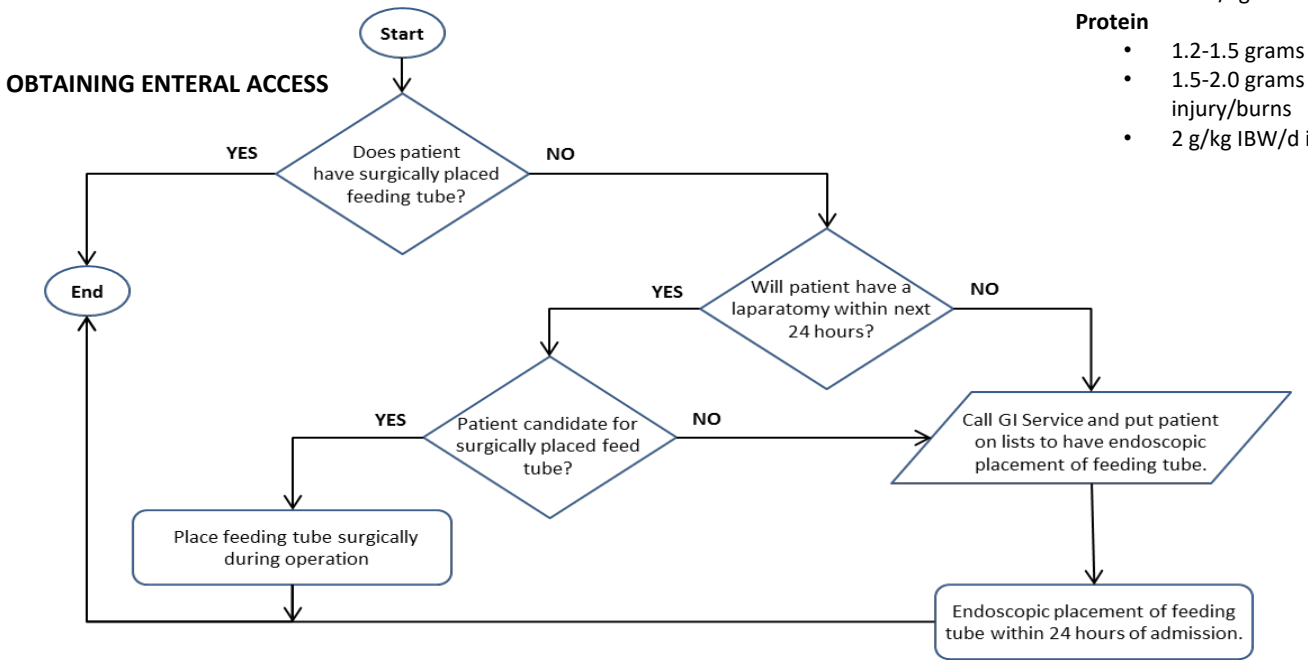
Kcals (total)

- 25-35 kcal/kg dry weight for stress/trauma/burns
- 20-25 kcal/kg dry weight for ventilated pts
- 11-14 kcals/kg actual body wt or 22-25 kcals/kg IBW if obese (BMI > 30)

Protein

- 1.2-1.5 grams protein/kg
- 1.5-2.0 grams protein/kg in trauma/head injury/burns
- 2 g/kg IBW/d in obese patients

OBTAINING ENTERAL ACCESS


Start
Does patient have surgically placed feeding tube?
YES
NO
End
Will patient have a laparatomy within next 24 hours?
YES
NO
Patient candidate for surgically placed feed tube?
YES
NO
Call GI Service and put patient on lists to have endoscopic placement of feeding tube.
Place feeding tube surgically during operation
Endoscopic placement of feeding tube within 24 hours of admission.

APPENDIX C: MANAGING ENTERAL FEEDING INTOLERANCE

MANAGING INTOLERANCE			
Indicator	**Severity**	**Definition**	**Treatment**
Vomiting	(Occurrence)	Any	• If no OG then place OG and start intermittent low wall suction • Check existing OG function/placement • IF OG placement correct, decrease TF infusion rate by 50% and call MD
Abdominal distention and/or cramping or tenderness (if detectable)	Mild	History and/or Physical exam	• Maintain TF infusion rate
	Moderate	History and/or Physical exam	• Maintain TF infusion. Do not advance • Order AP supine KUB x-ray • assess for small bowel obstruction If moderate distension for > 24 hrs, switch to elemental formula
	Severe	History and/or Physical exam	• Stop TF infusion • Monitor fluid status • Consider CBC, lactate, ABG, Chem7, CT scan abdomen • Check bladder pressure
Diarrhea	Mild	1-2 x /24 hr or 200-400 ml/24 hr	• Increase TF infusion rate per protocol
	Moderate	3-4 x / 24 hr or 400-600 ml/24 hr	• Maintain TF infusion rate. Do not advance • Evaluate patient for Clostridium Difficile per local hospital protocol • Consider soluble fiber (Nutrisource Fiber ®, 1 pkg BID, increase to 1 pkg QID). • Consider probiotics if not contraindicated.
	Severe	>4 x / 24 hr or >600 ml / 24 hr	• Decrease TF infusion rate by 50% • Review MAR: note antibiotic, bowel regimen, prokinetics, elixirs • Evaluate patient for Clostridium Difficile per local hospital protocol • If c. diff positive then treat appropriately and hold antidiarrheals for 48 hrs. • If c.diff negative give 2 mg loperamide after each loose stool • Order AP supine KUB x-ray to evaluate location of feeding tube • Consider switching to elemental formula • Monitor fluid and electrolyte status
High NG output	measured	>1200 ml / 12 hr	• Stop TF • Order AP supine KUB to evaluate location of OG and feeding tube ○ If OG past pylorus, pull back into stomach and resume tube feeds @ previous rate ○ If NJ in the stomach, consult GI to replace ○ If both tubes in correct position, decrease tube feed rate by 50% assess patient entirely • Check OG aspirate for glucose by lab ○ if glucose >110, hold TF, reassess in 12 hours ○ If OG aspirate glucose negative, resume TF at 50% previous rate
Medication Considerations	Inotropic agents e.g.,Dobutamine, Milrinone		• Advance feeding per protocol
	Paralytics and vasoactive agents: any paralytic continuous infusion, vasopressin >0.04units/min Dopamine > 10mcg/kg/min, Norepinephrine > 5mcg/min Phenylephrine > 50mcg/min, any epinephrine		• Elemental formula at 20mL/hr. Do not advance • Hold modular protein (Beneprotein/Prostat). • Consider concurrent TPN starting ICU day #7

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Ocular Evaluation and Disposition after Suspected Laser Exposure (CPG ID:79)

This CPG provides information and instructions for medical providers responsible for service members following a suspected directed energy exposure involving the visual system

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INTRODUCTION

This Clinical Practice Guideline provides information and instructions for medical providers responsible for Service members following a suspected directed energy (DE) exposure involving the visual system. (Consider: There is little experience in the general medical community with DE and having a high index of suspicious for this type of injury is important. If a DE exposure is suspected – early consultation with ocular care providers is important as is having a full understanding of the physiologic and anatomic effects of this type of injury. Ocular DE injury can result in mission compromise and pose safety hazards to the individual and the unit.) These suspected exposures, presumed caused by a laser or other intense bright light source, can compromise the ability to execute mission essential functions. For the purposes of this guideline, the term laser will also include any light source, visible or invisible, capable of resulting in potential injury. The intent of this guideline is to provide a better understanding of this type of injury and its effects and to establish a care algorithm for first-line providers and follow-on care by eye care providers. This CPG is based on expert consensus because there is little available data on this type of injury. Specifically, it includes the key elements of a Service member's history, examination, disposition, and medical record coding following potential exposures. Service and unit-specific reporting procedures for exposures and possible injuries are also included. Early recognition and treatment of potential injuries is essential to maintain optimal visual performance. In addition, timely reporting is essential to assess the operational impact of these exposures/injuries.

CLINICAL SCENARIOS

1. An aircrew making a final approach is exposed to a laser source, leading to temporary flash blindness. Spatial awareness and situational awareness is effected, compromising actions during critical operations. The symptoms resolve without functional or anatomic evidence of damage.

2. A mounted service member employs an escalation of force visible laser during operations. The beam is reflected of the turret mirror resulting in close proximity exposure. Central vision is immediately compromised. Evaluation shows decreased vision and retinal edema. This results in a central retinal scar and loss of vision.

BACKGROUND

Lasers emit nonionizing radiation in the ultraviolet, visible, and infrared portions of the electromagnetic spectrum. When the eye is exposed to this energy, temporary disruption of visual function or permanent injury may occur.[1] Lasers available for wide scale commercial purchase that emit at visible wavelengths (including red, green, and blue) have been increasingly reported in laser strikes on commercial aircraft. These laser strikes on commercial aircraft have been reported most frequently during takeoff and landing.[2] A review of these civilian aircraft incidents found that while these laser strikes have not resulted in any documented permanent changes in visual functional or structural damage to the eyes, they have been documented to cause immediate visual effects, including flash blindness, glare, and startle that can interfere with critical functions on board the aircraft. Based on reports by civilian pilots that have been directly exposed, recovery of optimal visual function can take from seconds to minutes. However, alterations in visual function can last from several minutes to several hours.[3]

Potential exposures of the visual system to laser threats that are present across the spectrum of military operations are more varied. Laser technology is incorporated into multiple weapons systems from both friendly and hostile forces and presents a threat of temporary visual effects or permanent injury to the eye. Most laser systems designed for military use emit at infrared wavelengths that cannot be seen by the human eye. Visible laser systems also pose a threat to military operations. A review of data from the Defense and Veterans Eye Injury and Vision Registry (DVEIVR) from 2006-2018, found 132 service members with documentation of exposure in the medical record. Of these cases reviewed, five service members found to have permanent damage compromising visual function as a result of exposure.

KEY POINTS

- Ocular exposure to directed energy in the form of lasers can acutely disrupt operational functioning.
- Permanent injury to the eyes and visual system is rare after these exposures.
- Awareness of this type of exposure is critical for all deployed providers.
- Early engagement of eye care specialist is essential to maximize recovery.
- Service members with persistent symptoms or worsening vision complaints require priority evacuation.
- Exposed Service members require comprehensive evaluation by an eye care provider as soon as possible after exposure events.
- Consistent documentation of exposures and injuries will improve treatment recommendations

EFFECTS OF EXPOSURE

Exposure of the eyes to laser energy generally leads to two categories of effects.

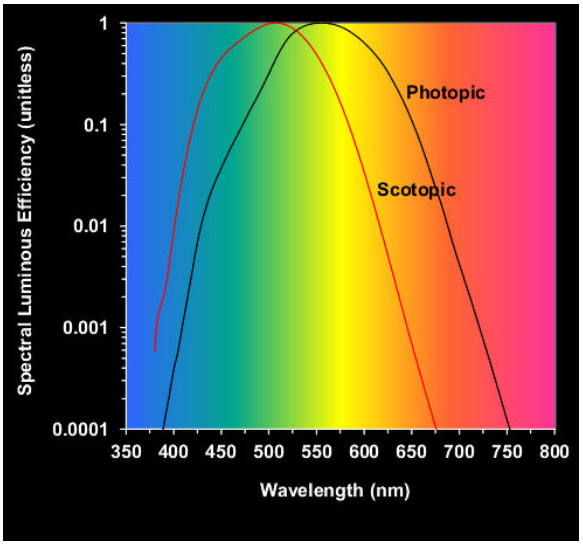
1. Visual interference effects
2. Ocular injury (persistent anatomic or visual function abnormalities)

INCIDENT WITH TEMPORARY VISUAL INTERFERENCE EFFECTS

These effects are the result of wavelengths in the visible spectrum (400-700 nm). The wavelength or color of the source is associated with the degree of immediate visual function disruption following an exposure. This is because the human eyes spectral response to color varies across the visible spectrum. We see the color green much better than blue or red. Our response to color even varies with lighting conditions. The vision we use under well-lit, daytime conditions is called photopic vision and under low-light levels, nighttime conditions is called scotopic vision. For example, green light is capable of producing visual function disruption with less relative power than red light at similar distances. Effects include temporary flashblindness, afterimages, and glare. They also include startle, distraction, and disruption, effects that may not directly degrade vision but may have an effect on human performance. These effects are more pronounced when a person is exposed at night or in a dark environment.

Figure 1. Spectral Response of the Eye

The standard photopic and scotopic sensitivities of the eye as defined by the Commission internationale de l'éclairage (CIE) or International Commission on Illumination are shown and demonstrate the peak sensitivity to green wavelengths. Note the logarithmic scale of the y-axis.



Visual interference effects include:

1. **Flash blindness** - A visual interference effect that persists as an afterimage after the source of illumination has ceased.
2. **Glare** – An obscuration of an object in a person's field of vision due to a bright light source located near the same line of sight.
3. **Afterimage** - A transient image that persists in one's visual field after a bright source of illumination has been removed.
4. **Startle** – The involuntary reaction to an unexpected event that alters mental, physical, and visual activities and diverts selected attention away from the normal primary tasks of an individual. The startle response can be broken into four specific categories: Distraction, Disruption, Disorientation, and Operational Incapacitation.
    - **Distraction** – Momentary attention shift from primary tasks due to sudden exposure to a bright light source. This effect may not be readily identified by the Service member and should be asked specifically.
    - **Disruption** – Interference or interruption of critical tasks or task sequences that extend the shift of attention from primary tasks requiring selective attention.
    - **Disorientation** – Losing perspective in the relationship between the direction of travel and surroundings. Can include loss of both spatial orientation and situational awareness. Disorientation can occur simultaneously with distraction, disruption, and startle.
    - **Operational Incapacitation** – An individual's loss of spatial orientation and loss of situational awareness in reference to the outside world. In the case of aviation, a pilot that becomes

operationally incapacitated should immediately transfer control of their aircraft because they can no longer reliably discern or control the aircraft.

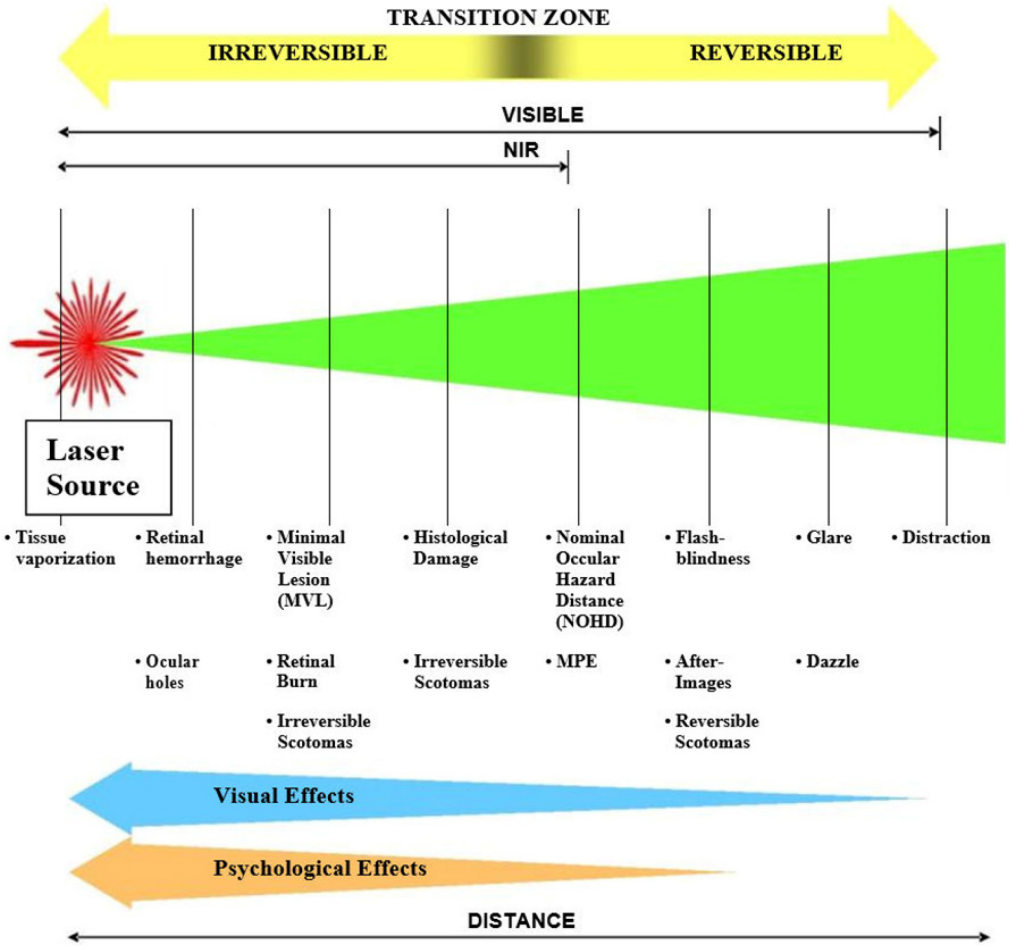
The natural aversion response to bright light sources limits exposure to visible wavelength lasers to about 0.25 seconds. Although exposure may be limited to a fraction of a second by your ability to blink or turn away from the offending light source it does not provide absolute protection from injury.

INCIDENT WITH SUSPECTED OCULAR INJURY

An ocular injury can result from any laser wavelength if sufficient power is delivered to the eye. The affected structure within the eye varies with wavelength. Lasers emitting in the far ultraviolet, UV-B and UV-C (180-315 nm), and far infrared, IR-B and IR-C (1400 nm – 1 mm), are absorbed by the cornea. Near ultraviolet, UV-A (315-400) wavelengths are absorbed by the lens of the eye. Visible (400-700 nm) and near infrared, IR-A (700-1400 nm) wavelengths are absorbed by the retina. The spectral region 400-1400 nm is commonly referred to as the retinal hazard region. Laser output power, or energy, is an important determinant for injury potential, as is the duration of the exposure and the exposed person's location relative to the laser source exit aperture.

Figure 2. Effects of laser and other intense/bright light exposures based on distance.

Source: AF Laser Injury Guide Book.



OPTICAL DEVICES

Vision enhancement devices, such as Night Vision Devices, provide an additional barrier between the laser and the eyes which can provide a degree of protection. However, they can be more sensitive to interference from intense light sources, both visible and non-visible wavelengths, especially compared to the unaided eye. This can cause difficulty with the device's operation and significantly affect safety.

Optical scopes, or other devices with magnifying optics, may amplify or further focus the light source, leading to more energy delivered to the eye and increased risk of injury.

EVALUATION OF SUSPECTED INJURY

All service members with a laser exposure require evaluation. The form below includes key points for documentation as well as recommended testing and intervals. Generally, service members should be evaluated at least daily until symptoms resolve or evacuation to an eye care provider is available. After evacuation out of theater frequency of follow-up is based on clinical situation, but should occur at a minimum of 1, 3, and 6 months following exposure/injury. Detailed sheets to guide the evaluation for all providers are available in Appendix A. These include sheets to guide initial providers through key history and examination elements, as well as more specialized recommendations for eye care providers. Medical documentation does not replace operational reporting as detailed below. These recommendations may be modified as new information is available through ongoing analysis of exposures and outcomes.

Use of the Laser Incident Questionnaire (Appendix B) enables both medical and operational aspects of the incident to be documented. Exposed/injured service members can expect to undergo more extensive interviews with additional medical, operational, and military intelligence personnel after treatment has been initiated.

TREATMENT & DISPOSITION

TREATMENT

Initial treatment guidance for suspected ocular injury from laser exposure is limited. Readily identifiable injuries such as corneal abrasions, hyphema or vitreous hemorrhage should be treated using current standards in coordination with an eye care provider. These guidelines can be found in the Eye Trauma: Initial Care, 28 Aug 2019 and Ocular Injuries and Vision-threatening Conditions in Prolonged Field, 01 Dec 2017. In the context of visual dysfunction, available literature suggests early treatment with non-steroidal anti-inflammatory drugs (NSAIDS) and/or systemic corticosteroid therapy.[4,5,6] Treatment of SMs with suspected ocular injury should be considered as follows (if not otherwise contraindicated):

1. **Vision 20/40 or better** but not at baseline, visual interference effects lasting more than 2-4 hours: start NSAID (indomethacin by mouth 25mg three times/day can be used if available, or ibuprofen 800mg by mouth three times/day

2. **Vision worse than 20/40**, any Amsler grid abnormalities: Consider addition of oral prednisone (0.5 to 1 mg/kg); teleconsultation with eye care provider recommended.

Evaluation by an eye care provider in theater should be obtained if operationally feasible. This decision is best made after discussion with the eye care provider. Teleconsultation for specific treatment decisions when no eye care providers is available.

Teleconsultation Services

- ADVISOR 833-238-7756; DSN 312-429-9089 (select emergency department and callers will be connected to ophthalmology) ADVISOR covers all Combatant Commands
- U.S. Air Force School of Aerospace Medicine Ophthalmology: 937-938-2675
- Naval Aerospace Medical Institute Ophthalmology: 850-452-2933; usn.pensacola.navmedotcnamefl.list.nami-ophthal@mail.mil

Asynchronous Consultation Services:

- INDOPACOM: Pacific Asychronous TeleHealth (PATH): https://path.tamc.amedd.army.mil/
- EUCOM, CENTCOM, AFRICOM, SOUTHCOM: Health Experts onLine Portal (HELP): https://help.nmcp.med.navy.mil/

***NOTE**: PATH and HELP links require establishment of an account*

Service members (SM) reporting worsening visual acuity or visual symptoms, or a change in exam findings should be considered for priority evacuation to allow for evaluation and care by an eye care provider. SMs with any visual symptoms that persist beyond 24 hours despite initial treatment should be considered for priority evacuation.

All SMs with symptomatic exposures, even those that return to baseline function, should have comprehensive evaluation by an eye care provider in theater or upon redeployment if resources are not available in theater. This post-exposure evaluation should be documented in the electronic medical record.

SMs with repeated exposures (multiple exposures over several days), should be evaluated for symptoms after each incident, and each evaluation documented and treated as an additional exposure.

DISPOSITION

Flight Surgeons

Follow Service-specific guidelines for aviation personnel; full references at end of CPG.

- United States Air Force School of Aerospace Medicine Laser Injury Guidebook
- OPNAV Instruction 5100.27B Marine Corps Order 5104.1C, Navy Laser Hazards Control Program[7]
- Army personnel should follow above guidance

***NOTE**: Aviation personnel are only to be returned to duty in accordance with Service-specific aviation guidelines from the above references and local SOPs.*

Other Forward Providers

SMs with exposures that return baseline visual function (with no new or persistent defects on Amsler grid testing, see Appendix C) within 2-4 hours may be returned to full duty without restrictions as long as the SM meets current service-specific standards. Full documentation and incident reporting is required for incidents with transient visual interference effects as well as suspected ocular injuries. Non-aviation personnel may return to duty when visual function returns to baseline and allows for effective execution of MOS-specific duties and operational requirements.

Eye care providers

1. Whenever feasible and operationally viable, obtain ultrastructural image of the retina as near to point of exposure as possible in SMs with persistent visual complaints. This will serve to further define the severity of injuries, serve as a baseline for visual recovery, and inform ongoing understanding of the spectrum of directed energy injuries as an evolving operational concern.
2. Service Members with suspected ocular injuries from laser exposure are eligible for enrollment in the DVEIVR https://vce.health.mil/Vision-Registry/Need-Access. The registry is populated using medical encounter documentation. Only unclassified details of the event should be entered into the medical record. Coding recommendations to facilitate tracking and analysis are listed below.
3. Service Members with documented retinal involvement should be referred to a vitreoretinal specialist for further evaluation.

MEDICAL CODING

The following ICD-10 coding guidance is recommended for laser exposures. Proper documentation and coding of these events allows for optimal tracking and analysis inform and evaluate treatment recommendations. Uniform and consistent medical documentation and coding is essential to proper surveillance and research efforts. This guidance is designed to standardize coding across the MHS.

Table 1. ICD-10 coding guidance for laser exposures

Diagnostic Position	Code	Comments
Principal/First listed Diagnosis	Initial symptoms (headache, blurred vision, etc.)	Allows for tracking duration/resolution of symptoms longitudinally
Second Diagnosis	Anatomic findings (burn, scar, etc.)	Allows for documentation and tracking of injuries longitudinally
Third Diagnosis	W90.2* Exposure to laser radiation	ICD-10 codes in the range V00-Y99 describe the cause of the morbidity, not the condition itself; this code allows for accurate tracking of laser exposures.
	W90.2XXA Exposure to laser radiation initial encounter	
	W90.2XXD Exposure to laser radiation subsequent encounter	
	W90.2XXS Exposure to laser radiation sequela	

INCIDENT REPORTING

1. Notify Chain of Command at the earliest level possible.
2. Notify the DoD Laser Hotline as soon as time and circumstances permit:
   - DoD Laser Hotline Toll-free: 800-473-3549 (not currently manned 24/7)
   - https://hpws.afrl.af.mil/dhp/OE/ESOHSC/laserinjury/
   - US Army Institute of Surgical Research (MCMR-SRR-O), Ocular Trauma and Vision Restoration,
   - https://usaisr.health.mil/, Trauma Clinic & Civilian Care Coordination Office (CCCO) phone 210-916-2796.
3. Notifications as outlined in the Air Force Occupational Safety and Health Standard, AFI48-139 should be made as soon as possible. Field level notification should be made to the Deployed Medical Commander and the Air Expeditionary Wing Commander. Notify the Tri Service Laser Injury Hotline (1-800-473-3549) as soon as time and circumstances permit.
4. Medical personnel can coordinate medical guidance for laser injuries from the DoD Laser/EMF Injury Hotline through the ESOH Service Center, (800) 473–3549, DSN 798–3764, commercial (937) 938–3764, or email esoh.service.center@wpafb.af.mil. Upon examination, if the medical facility suspects or confirms the over exposure, they contact the injured person's commander or supervisor.
5. For Army Aviation, Commander, U.S. Army Combat Readiness Center (CSSC–Z), Fort Rucker, AL, at DSN 558–2660/3410, commercial (334) 255–2660/3410 (24-hour phone line), FAX DSN 558–3749, commercial (334) 255–3749 or email helpdesk@crc. army.mil.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with laser eye exposure/injury.

INTENT

1. Patients in the population of interest are identified as having exposure at first role of surgical care.
2. Patients in the population of interest undergo comprehensive evaluation by an eye care provider as soon as possible after exposure events
3. Patients in the population of interest have complete documentation of type of laser injury, severity, treatment, and outcomes.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with documented comprehensive eye exam.
2. Number and percentage of patients in the population of interest with complete documentation of type of laser injury, severity, treatment, and outcomes.

DATA SOURCES

- Individual Medical Record
- DVEIVR
- DoD Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief, JTS Program Manager, and the JTS Performance Improvement Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

ACKNOWLEDGMENTS

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APPENDIX A: EVALUATION & DOCUMENTATION SHEETS FOR PROVIDERS

Laser Exposure Medical Documentation: Initial Provider Evaluation		
Patient		
Identifier		
Date of Injury		
Date of Evaluation		
History		
Element	**Description**	**Result**
Exposure description	Color, brightness and duration of light/exposure	
	Other characteristics of light (pulse/flicker)	
	Eye(s) exposed	
	Direct or reflected exposure	
	Activity/tasks at time of exposure and ability to perform tasks.	
	Optical devices in use at the time of suspected exposure (night vision devices, magnifying devices, specific laser protection devices)?	
Presenting Symptoms	Reported symptoms may include: blurred vision, headache, blind spots, shadows, eye pain, eye irritation/burning, etc.	
Time since exposure	How long ago was the exposure?	
Duration of symptoms	Seconds, minutes, hours, ongoing	
Medical/Ocular History	Previous visual function (baseline vision as available (i.e. glasses use)	
	Previous ocular history	
	History of refractive surgery	
	Current medications	
Social History	Tobacco use	
Examination		
Element	**Description**	**Result**
Laterality (OD/OS/OU)	Accomplished at every visit. Document affected eye(s)	
Visual Acuity	Accomplished at every visit. Note whether acuity was taken at near or distance, and whether acuity was accomplished with or without correction; annotate whether spectacles or contacts were used.	

Laser Exposure Medical Documentation: Initial Provider Evaluation		
Amsler grid* testing (*Appendix B*)	Accomplished at the initial visit, and at follow-up for previously documented abnormality or where new symptoms are disclosed ; document abnormalities or "normal" in each eye	
Color Vision testing	Accomplished at the Initial visit, and at follow-up for previously documented abnormality or where new symptoms are disclosed performed at follow-up if new abnormality; document abnormalities or "normal" in each eye computerized color vision testing, monocular, with red, green, blue cone testing individually preferred if available (pseudoisochromatic plates are not considered adequate for this testing, but may be used for initial screening)	
Pupils	Document size, shape, and reactivity	
External eye	Evaluate for irritation, burns, corneal opacities; Document abnormalities or "normal" in each eye	
Retinal evaluation	Accomplished at the Initial visit, and at follow-up for previously documented abnormality or where new symptoms are disclosed performed at follow-up if new abnormality; document abnormalities or "normal" in each eye	
Additional evaluation	Flight Surgeons complete additional evaluation and testing required for aviation personnel based on training and Service-specific guidelines.	

*The Amsler grid is a printed grid pattern with a central dot. It is designed to demonstrate alterations in vision near fixation (the area of highest acuity). See Appendix C for details of use.

APPENDIX B: LASER INCIDENT QUESTIONNAIRE

The following questions taken from the AFRL-SA-WP-SR-2012-0005, are designed to gather information to assist medical, operational, and intelligence personnel in analysis of laser beam exposure incidents. It should be anticipated that further questions and information will be sought as time allows. Finally, remember to call the Tri-Service Hotline at 1-800-473-3549 or DSN798-3764 as soon as possible.

1. Describe the light you saw

- What color(s) was the light(s)?
- How bright was it?
- How long was it on?
- Was it uniform in appearance?
- Did the intensity of the light change?
- Was it constant or did it pulse or flicker? If so, how fast did it pulse or flicker?
- How wide (perhaps using finger widths at arm's length) was the beam at origin?
- How wide on exposure was the light? Did the light fill your cockpit or compartment?
- Was the light emanating directly from a source or was it reflected off a surface?
- Were there any other unusual light sources?
- Have you seen this light(s) before?

2. Date, location, and circumstances

a. Date and time (local & Zulu using a 24-hour clock) that the exposure occurred.

local: DDMMYYYY hh:mm

Zulu: DDMMYYYY hh:mm

b. Location of exposure (if nonclassified). Describe location preferably using degree decimal (DD), degrees-minutes-seconds (DMS), Universal Transverse Mercator (UTM), or Military Grid Reference System (MGRS).

c. How far and in what direction was the light source? Was it airborne or surface based?

d. What was between the light source and your eyes?

e. What were the atmospheric conditions: clear, overcast, rainy, foggy, hazy, and sunny?

f. Was any equipment such as windscreens, visors, NVGs, goggles or sensors affected by the light?

g. What evasive maneuvers did you attempt and did the beam follow you as you tried to move away?

3. Effects

a. How long did you look into the light beam?

b. Did you look straight into the light beam or off to the side?

c. What tasks were you doing when the exposure occurred? Did the light(s) hamper you from doing those tasks?

d. Were both eyes exposed? If not, describe the difference between the light exposure (for example, one eye was shielded or closed, or on the side away from the light beam).

e. Describe any difference in the effect on either eye.

f. Was the light so bright that you had to blink or squint, close your eyes, or look away?

g. Was the light painful? Describe the pain. For how long did the pain persist after the light exposure?

h. Was vision affected while the light was on? How much of your visual field was affected? What types of things could you see or not see? Did you notice the color of instruments or targets change? Did the changes to your vision remain constant or vary during the exposure? If the light source was mounted on a platform (e.g., aircraft, ground vehicle, or building), how much of the platform was obscured?

i. Did your vision remain affected after the light was extinguished? If so, for how long and how did you estimate the time? What types of things could you see or not see? Did you notice afterimages (“spots before your eyes”)? If so, describe them.

j. Were there any lingering (i.e. hours or days) visual effects? If so, were the effects continuous or intermittent? Did you have problems reading or seeing in low-light conditions? How long until you were able to see normally again?

k. Did you notice any reddening, warming, or burns to your skin?

l. Describe the condition of your vision before the incident. Do you wear glasses?

m. Are you taking any medications?

APPENDIX C: AMSLER GRID/FOVEAL GRID TESTING INSTRUCTIONS

An accurate and validated grid for testing with instructions (Aidman Vision Screener) is available through the U.S. Army Public Health Center, Health Information Products e-Catalog: https://usaphcapps.amedd.army.mil/HIOShoppingCart/viewItem.aspx?id=452.

If pre-printed copies are not available, the vision screener may be printed full size for expedient screening.

GENERAL INSTRUCTIONS:

1. Have Service Member wear current glasses or correction if normally used for near vision.
2. Evaluate each eye separately under good lighting conditions, begin with the right eye (cover left eye).
3. Hold the sheet 40 cm/16 inches from the eye.
4. Ask Service Member to:
    a. Describe the center of the grid (may be unable to see center)
    b. Determine if all four corners of the diagram are visible.
    c. Identify any dark, hazy, or missing areas on the grid while SM focuses on central dot. Have SM draw these areas on the chart.
    d. Identify any distorted or wavy lines on the grid while focusing on the central dot. Have SM draw these areas on the chart.
5. Repeat test for left eye (cover right eye).
6. Document Amsler grid testing in medical record.

Laser Exposure Medical Documentation: Initial Provider Evaluation		
Patient		
Identifier		
Date of Injury		
Date of Evaluation		
History		
Element	**Description**	**Result**
Exposure description	Color, brightness and duration of light/exposure	
	Other characteristics of light (pulse/flicker)	
	Eye(s) exposed	
	Direct or reflected exposure	
	Activity/task at time of exposure and ability to perform tasks.	
	Optical devices in use at the time of suspected exposure (night vision devices, magnifying devices, specific laser protection devices)?	

Laser Exposure Medical Documentation: Initial Provider Evaluation		
Presenting Symptoms	Reported symptoms may include: blurred vision, headache, blind spots, shadows, eye pain, eye irritation/burning, etc.	
Time since exposure	How long ago was the exposure?	
Duration of symptoms	Seconds, minutes, hours, ongoing	
Medical/Ocular History	Previous visual function (baseline vision as available (i.e. glasses use)	
	Previous ocular history	
	History of refractive surgery	
	Current medications	
Social History	Tobacco use	
Examination		
Element	**Description**	**Result**
Laterality (OD/OS/OU)	Every visit. Document affected eye(s)	
Visual Acuity (best corrected)	Accomplished at every visit.	
Amsler grid* testing	Accomplished at the initial visit, and at follow-up for previously documented abnormality or where new symptoms are disclosed ; document abnormalities or “normal” in each eye	
Color Vision testing	Accomplished at the Initial visit, and at follow-up for previously documented abnormality or where new symptoms are disclosed performed at follow-up if new abnormality; document abnormalities or “normal” in each eye computerized color vision testing, monocular, with red, green, blue cone testing individually preferred if available (pseudoisochromatic plates are not considered adequate for this testing, but may be used for initial screening)	
Pupils	Document size, shape, and reactivity	
External eye	Evaluate for irritation, burns, corneal opacities; Document abnormalities or “normal” in each eye	
Retinal evaluation	Accomplished at the earliest role of care with available technology. Repeat testing should be done to monitor for progression based on the clinical situation.	
Ocular Coherence Tomography (OCT	Flight Surgeons complete additional evaluation and testing required for aviation personnel based on training and Service-specific guidelines.	
Automated Visual Field (VF)	Accomplished at the earliest role of care with available technology. Repeat testing should be done to monitor for progression based on the clinical situation.	

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Ocular Injuries and Vision-Threatening Conditions in Prolonged Field Care (CPG ID: 66)

This guide provides medical professionals with essential information on the recognition and treatment of ocular conditions when evacuation to an eye specialist is delayed.

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INTRODUCTION

Evaluation and treatment of ocular injuries and vision threatening conditions in a prolonged field care (PFC) situation can be extremely challenging. These events can lead to irreversible loss of vision with lasting effects on military service and overall quality of life. The goal of this clinical practice guideline (CPG) is to provide medical professionals with essential information on the recognition and treatment of ocular conditions when evacuation to an eye specialist is delayed. The guidelines are based on standard ophthalmic practice adapted to address the austere or remote environment, when the "Shield and Ship" guidelines are interrupted by delayed evacuation.

As with all medical concerns, recognition of the problem is the first step. This is a particular challenge for ocular conditions. Comprehensive ocular evaluation is not usually possible in austere locations and training in rapid recognition of ocular conditions may be limited. The ocular conditions covered in this guideline are the most common traumatic injuries and vision-threatening conditions that require rapid identification and treatment to prevent loss of vision. A more comprehensive review can be found in the Joint Trauma System CPG[1] or Wilderness Medicine textbook.[2]

Telemedicine: Management of eye injuries is complex. Detailed physical examination information can only be communicated via pictures or video. Establish telemedicine consultation as soon as possible.

GOALS OF CARE

1. MAINTAIN HIGH SUSPICION FOR OCULAR INJURIES

The mechanism of injury will often suggest an ocular injury. Direct trauma with ocular laceration may be fairly obvious, but blunt trauma leading to an occult rupture on the posterior aspect of the globe or injury to the retina can be easily overlooked in a multitrauma patient. Small metallic fragments can penetrate the eye and leave it appearing deceptively intact. An awake and alert patient can report change in vision or eye pain; an unconscious patient cannot. Thermal burns to the face frequently cause eyelid burns and contraction, which increase the risk for exposure keratopathy. Critical details in the evaluation of ocular trauma include mechanism of injury and presence of properly worn ballistic eyewear at the time of injury.

2. ASSESS AND DOCUMENT VISUAL FUNCTION

Visual acuity is the vital sign of the eye. Whenever possible, visual acuity should be assessed and documented. Visual function immediately after trauma is an important prognostic indicator for visual outcome. Visual acuity can be effectively estimated with several field-expedient methods, starting with ability to read any printed letters such as labels on medical supplies. If the patient is unable to read letters, assess their ability to count fingers. If they cannot count fingers, evaluate for the ability to detect hand motions. If they cannot detect hand motion, evaluate light perception using a bright light. Document visual acuity along with other vital signs.

Assessing for a relative afferent pupillary defect (RAPD, also called the swinging flashlight test or Marcus Gunn Pupil; Appendix A) gives an indication of retina and optic nerve function. Shine a light in either eye; normally, both pupils should constrict equally. This reaction to light is equal unless there is damage to the optic nerve or the retina, in which case the pupil of the injured eye will dilate when the light is shone in the injured eye. Evaluating for an RAPD is essential in conditions such as retrobulbar hemorrhage (orbital compartment syndrome) or suspected retinal detachment. Notation of an RAPD is also an important prognostic factor for ophthalmic providers at later level of care.

3. EXAMINE FOR CRITICAL PHYSICAL FINDINGS

An obvious globe laceration or rupture with prolapsed intraocular contents can be a striking picture but may not be present in every severe eye injury. At times, the only findings of a significant eye injury may be penetrating periocular trauma or lid lacerations, a peaked or teardrop pupil, or abnormal anterior chamber depth.

Estimation of intraocular pressure (IOP) is essential in injuries such as retrobulbar hemorrhage, but is contraindicated in injuries with obvious or suspected open globe injury (OGI). If no OGI is suspected, IOP can be estimated using a two finger method. Using the index finger of each hand, gently apply alternating pressure on the globe through closed lids. There should be mild indentation of the eye with normal IOP (normal range, 10–21mmHg). With increased IOP, the globe will be much firmer when compared to the opposite eye, or the examiner's own eye. The orbit around the eye may also feel tense in a retrobulbar hemorrhage.

A more detailed examination of the eye can be facilitated by the use of a direct ophthalmoscope for magnification. The examiner can use the plus lens dial (green or black numbers) to provide additional magnification. Details are found in Appendix B Use of the Direct Ophthalmoscope. Although deployed locations may have specific guidance against contact lens use, this may still be encountered. If a contact lens is clearly visible and accessible, it can be gently removed with forceps. Fluorescein will stain a contact lens, allowing for easy visualization.

4. MAINTAIN PATIENT COMFORT. PREVENT FURTHER DAMAGE.

Pain control is an important component of care in ocular injuries. Standard Tactical Combat Casualty Care (TCCC) pain control guidance applies to ocular injuries, including analgesic doses of ketamine if needed in systemic polytrauma. Additional guidance for pain control in PFC may be found in the CPG *Analgesia and Sedation Management during Prolonged Field Care*.[3]

Pain is not always present with serious eye injuries, and lack of pain should not be interpreted as lack of injury. Ocular injuries can cause a great deal of anxiety for patients, and this may affect care. A benzodiazepine may be added to the treatment plan for anxiety control and facilitation of care (diazepam 10 mg by mouth [PO] every 6 hours as needed).

A traumatized eye is highly susceptible to further damage; antiemetic medications are essential to prevent retching and increased pressure that can have significant effects on visual outcome.

Patching both eyes to decrease sympathetic eye movements has not been shown to improve visual outcome. Occluding both eyes will render the patient unable to move independently, may increase anxiety, and may put the patient and provider at increased risk in any PFC environment. The use of standard eye protection during patient transport can reduce the risk of further ocular injury or injury to the fellow eye. Eye protection can be used over a rigid shield to provide increased protection.

5. ESTABLISH CONTACT WITH EYE CARE SPECIALIST. PRIORITIZE EVACUATION.

Determining the full extent of ophthalmic injuries and the resultant threat of permanent loss of vision is challenging without full ophthalmic training and equipment. All potential vision-threatening injuries should be evacuated with a goal of care by an eye surgeon within 24 hours. In some cases, with prompt teleconsultation or video consultation, it may be safe to delay evacuation to reduce the effect on the operational situation while providing necessary ophthalmic care. Evacuation within 24 hours is not possible in all situations; therefore, the goal of teleconsultation and forward care is to reduce morbidity and achieve the best possible outcome. In some operational environments, optometrists may be available to provide additional care or consultation closer to the point of injury.

Ocular examinations have many specialized components that a specialist may request. An example template with explanation can be found in Appendix C Basic Ocular Examination.

SPECIFIC CONDITIONS

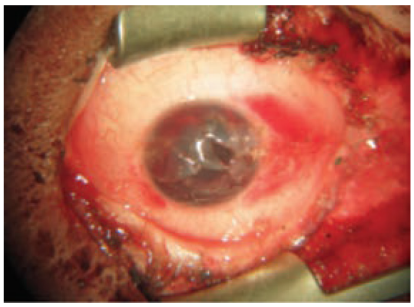
1. OPEN GLOBE INJURY

OGIs can result from penetrating/perforating trauma or from rupture of the globe due to massive compressive forces (Figures 1–5). Prompt surgical exploration and repair are crucial to restore or salvage vision and to prevent a devastating outcome. Safe and effective closure of an OGI is not yet feasible in a prehospital setting.

Figure 1. Open globe injury with corneal laceration, abnormal pupil shape, and blood in anterior chamber.

Figure 2. Central corneal laceration and lid laceration (due to large intraocular foreign body).

Figure 3. Multiple, deep corneal lacerations, found to be closed globe injury on surgical exploration.



Photographs by COL Mark Reynolds.

Goals

Prevent further damage to the eye, prevent infection in the eye (endophthalmitis), and evacuate to an eye surgeon as soon as possible.

Minimum

- Maintain high suspicion for OGI; treat any suspected open globe as an open globe until surgical exploration is available.
- Obtain and record visual acuity from the injured and noninjured eye.
- Apply a rigid eye shield without any type of gauze or bandaging under the shield to prevent further damage, per TCCC guidelines.4
- Initiate endophthalmitis prophylaxis with moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily; if intravenous (IV) administration is necessary, ertapenem 1g IV or intraosseously (IO) daily.5 Initiate pain control as needed.
- Initiate antiemetic (ondansetron 4mg oral dissolving tablet [ODT] IV/IO or intramuscularly [IM] every 8 hours as needed).
- Raise head 30°–45°.
- Activate evacuation with the goal of surgery within 24 hours.
- Initiate teleconsultation with photographs.

Better

- Minimize patient movements; maintain supine position with head at 30°–45°.
- Maintain endophthalmitis prophylaxis with an additional dose of moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily; if IV administration is necessary, ertapenem 1g IV/IO daily and the addition of clindamycin 300mg PO or IV every 8 hours if available; this is to cover Bacillus cereus, a particular concern in contaminated OGI.6
- Maintain antiemetic and pain control.

Best

- Perform a detailed ocular evaluation to include visual acuity and RAPD, and note any suspicious findings.
- Evaluation should be repeated with any reported change in vision or pain level by the patient. If symptoms are stable, perform ocular evaluation every 4 hours and before transfer.

Initiate real-time video telemedicine consultation.

- Coordinate surgical care within 8 hours of injury.
- No altitude restrictions are required for OGIs.

NOTES:

- Ultrasound is contraindicated for suspected OGI because it places pressure on the eye.
- Rigid eye shields are available in several different designs. Fit should be checked to ensure protection without any pressure on the eye. Standard eye protection may also be used to shield the injured eye.

Figure 4. Open globe with posterior rupture and collapsed anterior chamber.

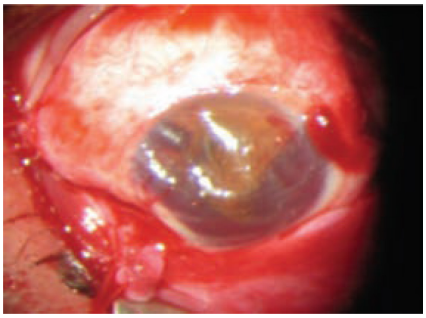
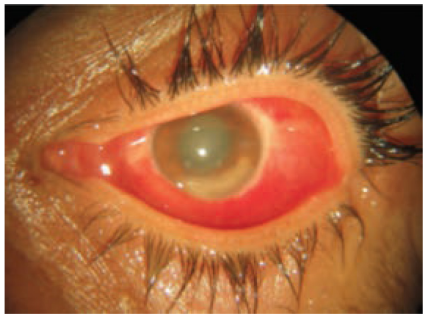


Figure 5. Post-traumatic endophthalmitis with inflamed conjunctiva, and inflammatory cells layered in anterior chamber.



Photographs by COL Mark Reynolds.

2. RETROBULBAR HEMORRHAGE / ORBITAL COMPARTMENT SYNDROME

Retrobulbar hemorrhage (RBH) is the most common cause of orbital compartment syndrome (OCS). It is a result of bleeding into the confined orbital space behind the eye, usually associated with blunt trauma (Figures 6 and 7). It is a vision-threatening condition causing increased pressure in the eye, leading to irreversible vision loss. Vision loss typically will occur after approximately 90 minutes of increased pressure.

Figure 6. Retrobulbar hemorrhage (pupil dilated for examination).

Figure 7. Retrobulbar hemorrhage, evaluation for proptosis.

Photographs by COL Mark Reynolds.

Other causes of OCS include orbital congestion secondary to burn resuscitation and significant orbital emphysema after orbital fracture (pneumo-orbita). OCS from any cause may have a delayed onset. Patients with trauma to the orbit must be closely monitored for development of OCS.

Goal

Lower the orbital compartment pressure as soon as possible to prevent tissue damage.

Minimum

- Prompt recognition of injury and identification of the need for intervention
- History of trauma with any of the following findings:
  - Proptosis: bulging of the affected eye compared with the other eye; proptosis in RBH is often tense and painful
  - Increased orbital pressure around the eye or IOP by palpation (increased firmness and resistance compared with opposite eye)
  - Decrease in or loss of visual acuity
  - Presence of an RAPD (Appendix A)
- Raise head 30°–45°.
- Initiate pain control as needed.
- Initiate antiemetic (ondansetron 4mg ODT/IV/IO/IM every 8 hours as needed).
- Perform lateral canthotomy/cantholysis (LCC) as soon as possible, within 90 minutes of injury if evacuation to a surgical capability is anticipated to take more than 60 minutes.
- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Initiate teleconsultation with photographs.

Better

- Minimize patient movements; maintain supine position with head at 30°–45°.
- Ice packs and avoidance of compressive dressings[7]
- Monitor for return of elevated orbital pressure.

Best

- Initiate a detailed ocular evaluation and continue monitoring IOP, vision, and RAPD.
- Continue to check for recurrence of elevated IOP even after LCC. If the vision deteriorates and the eye again becomes firm after LCC, this may signify rebleeding in the orbit. Evacuation of orbital hemorrhage is not feasible in a PFC environment and rebleeding will require medical treatment.[8]
  - Acetazolamide: 500mg PO initial dose, followed by 250mg PO 4 times per day (Note: contraindicated in patients with sickle cell trait)
  - If acetazolamide is not available or if the patient cannot take PO, either 3% hypertonic saline 250mL IV or mannitol: 1g/kg IV over 30–60 minutes can be used to decrease IOP.[9]
  - Corticosteroid: 1g methylprednisolone IV once [10]
  - Initiate real-time video telemedicine consultation.
  - No altitude restrictions are required for evacuation.

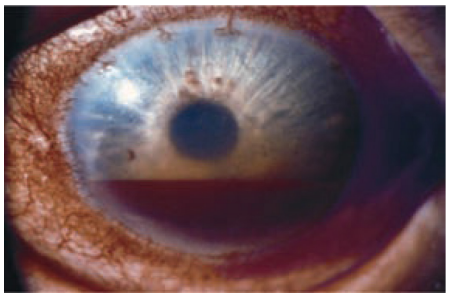
NOTES:

- LCC is a vision-saving procedure with minimal risk of causing additional ocular injury. When in doubt, perform the LCC immediately.
- In thermal burns, consider early LCC (before full OCS develops). Fluid resuscitation requirements will take precedence over the use of medical treatments to reduce IOP.

3. BLUNT / CLOSED GLOBE INJURY

This category includes anterior segment injuries such as hyphema (bleeding into the anterior chamber) and posterior segment injuries such as vitreous hemorrhage and retinal detachment. Blunt trauma can result in severe loss of vision.

Figure 8. Layered hyphema in anterior chamber.



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Hyphema can lead to increased IOP and corneal blood staining. This is graded on the amount of blood in the anterior chamber. The risk of IOP elevation increases with the grade of the hyphema (Figure 8).[11]

- Grade 0: no visible blood layering
- Grade 1: blood fills less than one-third of anterior chamber
- Grade 2: blood fills one-third to one-half of anterior chamber

- Grade 3: blood fills one-half to less than total anterior chamber
- Grade 4: blood fills entire anterior chamber

Goal

Identify significant ocular injuries; protect the eye from further injury.

Minimum

- Obtain and record visual acuity and critical injury details (e.g., mechanism of injury, presence of eye protection).
- Protect the injured globe and prevent further damage with a rigid shield.
- Raise the head 30°–45°; this allows any free-floating blood in the anterior chamber to settle away from the pupil and prevent pupillary block (which can lead to angle closure and elevated IOP).[11]
- Initiate pain control as needed; avoid nonsteroidal anti-inflammatory drugs, because of risk of worsening intraocular bleeding.
- Prevent further injury with antiemetics (ondansetron 4mg ODT/IV/IO/IM every 8 hours as needed).
- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Initiate teleconsultation with photographs.

Best

- Initiate a detailed ocular evaluation to direct treatment.
- Hyphema (anterior chamber injury)[11]
- Topical corticosteroid drop (prednisolone acetate 1%) 4 times per day
- Cycloplegic eye drop (cyclopentolate 1%), 1 drop every 8 hours
- Monitor for rebleeding when the clot in anterior chamber retracts, usually at 3–5 days after injury.
- This may result in vision change and increased size of hyphema.[12]
- If there is evidence of further bleeding or increasing IOP, initiate medications to decrease IOP:
  - Timolol 0.5%, 1 drop twice a day in affected eye
  - Acetazolamide 500mg PO initial dose, followed by 250mg PO 4 times per day (Note: contraindicated in patients with sickle cell trait) or 3% hypertonic saline 250mL IV or mannitol: 1g/kg IV over 30–60 minutes.

NOTE: Tranexamic acid for prevention of rebleeding in hyphema has not shown any benefit [13] but may be used in multitrauma patients if otherwise indicated.

Posterior chamber injury: Injuries to the retina and optic nerve as a result of blunt injury will result in vision loss. Findings may include decreased visual acuity, vision loss, loss of red reflex through the pupil, positive RAPD, or evidence of vitreous hemorrhage or retinal detachment on ultrasound evaluation.

- Initiate supplemental oxygen as available if suspicious for retinal detachment (e.g., cut in visual field, decreased vision, positive RAPD); this may improve visual outcome.[14]
- If no evidence of OGI, perform careful ultrasound to evaluate vitreous and retina, if available/trained. Transmit ultrasound images with telemedicine consultation to an eye specialist.

Initiate real-time video telemedicine consultation.

- No altitude restrictions are required for blunt/closed globe injury.

4. EYELID LACERATION

Lid lacerations can result from either sharp or blunt trauma (Figures 9–11). As with other injuries, the primary concern with lid injuries is the possibility of underlying globe injury. Lid lacerations have a low incidence of infection (unless the causative factor is an animal or human bite). Any avulsed tissue should be preserved in saline and chilled, whenever possible, and sent with the patient—not discarded or debrided. Meticulous closure of eyelid structures with proper magnification is usually required to maintain lid function. If fat is visible in an eyelid laceration, this indicates violation of the orbital septum, a key anatomic barrier to infection. If prolapsed orbital fat is identified, appropriate antibiotic coverage is needed as well as expedited evacuation for surgical exploration and repair. Do not attempt to excise or suture exposed orbital tissue; this can lead to uncontrolled bleeding in the orbit.

Figure 9. Eyelid margin laceration

Figure 10. Complex lid laceration with medial canthus avulsion

Figure 11. Eyelid laceration with tissue loss due to camel bite.

Photographs by LTC Marcus Colyer (9) and COL Mark Reynolds (10, 11).

Goals

Prevent infection; protect the eye from further injury.

Minimum

- Maintain high suspicion for OGI; treat any suspected open globe as such until surgical capability is available.
- Obtain and document visual acuity from the injured and noninjured eyes.
- If there is any concern for OGI, protect the injured globe and prevent further damage with a rigid eye shield. Polyethylene film (food grade) may be used to cover the eyelid wound under the rigid shield to prevent drying of the injured tissue.
- Initiate pain control as needed.
- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Initiate teleconsultation with photographs.

Better

For foreign body penetration, animal bite, or laceration with visible orbital fat, start antibiotics: moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily or amoxicillin/clavulanic acid 875mg/125mg PO every 12 hours or ertapenem 1g IV/IO daily.

Best

- Initiate a detailed ocular evaluation to include visual acuity, RAPD, and note any suspicious findings.
- Irrigate wound very gently with clean water (or sterile saline, if available).[15]
- Do not debride any tissue.
- Temporary closure with steristrips
- Tetanus prophylaxis
- Consider the need for rabies vaccination.[15]

Initiate real-time video telemedicine consultation.

- No altitude restrictions are required for evacuation.

5. ORBITAL FRACTURE

Fracture of the orbital bones occurs when an object that is larger than the width of the orbit (e.g., fist or softball) strikes the orbit. The acute expansion of orbital contents and mechanical buckling forces can result in fractures of the medial wall or orbital floor. This can cause herniation of orbital contents into the surrounding sinuses and entrapment of the extraocular muscles in the fracture site. Physical examination findings consistent with orbital fracture include a palpable and painful step-off along the orbital rim, enophthalmos (globe is further back in the orbit compared with the other eye), restricted eye movement, and numbness below the eye (caused by damage to the infraorbital nerve).[16] Trismus and malocclusion may indicate a larger zygomaticomaxillary complex fracture. Orbital fractures are not ophthalmic emergencies but may require surgical treatment to prevent the complication of double vision from ocular misalignment.

Goals

Evaluate for concurrent open or closed globe injury and prevent long-term complications.

Minimum

- Maintain a high suspicion for associated OGI; treat as a suspected open globe until eye surgical evaluation is available.
- Obtain and record visual acuity from the injured and noninjured eyes.
- Instruct the patient not to blow nose. This may force air into the orbit through fracture site, leading to OCS from pneumo-obita, which would require LCC.
- Initiate pain control as needed.
- Raise head 30°–45°.

Initiate teleconsultation with photographs.

- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Better

- Initiate antibiotics if an orbital fracture suspected; this is to prevent sinus pathogens from spreading to the orbital tissues: moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily or amoxicillin/clavulanic acid 875mg/125mg PO every 12 hours or ertapenem 1g IV/IO daily.
- Nasal decongestants such as oxymetazoline (e.g., Afrin; Bayer, http://www.bayer.us/) nasal spray twice a day for 3 days (limit use to 3 days to prevent rebound effect). Oral decongestants, such as pseudoephedrine 30mg every 6 hours, can be used if nasal spray is not available.
- Prevent further injury with antiemetics (ondansetron 4mg ODT/IV/IO/IM every 8 hours as needed).

Best

- Initiate a detailed ocular evaluation to include visual acuity, RAPD, and note any suspicious findings.
- Ice packs for 20 minutes every 1–2 hours for the first 48 hours to reduce swelling.
- Monitor for delayed development of OCS and perform LCC as needed.

Initiate real-time video telemedicine consultation.

NOTES:

- No altitude restrictions are required with orbital fractures, but patient should be monitored for increasing pain and/or decreasing vision from pneumo-orbita OCS requiring LCC.
- An important consideration in orbital floor fractures is the inferior rectus muscle becoming entrapped in the fracture (so-called trapdoor fracture). The resultant traction on the rectus muscle can trigger the oculocardiac reflex and result in intractable nausea and vomiting, symptomatic bradycardia, and possibly heart block. Although this is more common in pediatric patients (termed "white-eye" blow-out fractures), it is not exclusive to the pediatric population and has been reported in young healthy adults. Urgent surgical repair (within 72 hours) is recommended for an entrapped fracture with these symptoms.

6. CHEMICAL INJURIES

Acid (e.g., sulfuric, hydrochloric) and alkali (e.g., bleach, lime, ammonia) burns can cause significant injuries leading to permanent loss of vision and are considered ophthalmic emergencies. Alkali burns are more common and have more potential for damage than acid burns.16 Ongoing ocular care beyond the initial thorough irrigation will be required if evacuation is delayed. Chemical injuries are graded on a scale of I to IV.[17] The modified Hughes classification (Table 1) can be used to grade the degree of limbal ischemia that correlates with prognosis. Regardless of the chemical causing the injury, immediate irrigation is the essential first step. Additional treatment will be based on grade of injury. Injuries are graded on the basis of the following examination findings (Figures 12–14):

Table 1. Modified Hughes Classification

Grade	Cornea Epithelium	Corneal Clarity	Limbal Ischemia
I	Less than one-third loss	Iris details clearly visible	No ischemia
II	More than one-third epithelial loss	Iris details blurred but visible	Less than 25% ischemia
III	Complete epithelial loss	Pupil can be seen	25%–50% ischemia
IV	Complete epithelial loss	Opaque cornea	More than 50%

- Corneal epithelial damage: How much epithelium has been lost?
- Clarity of cornea: Can the normal structures (iris, pupil) be seen through the cornea?
- Limbal ischemia: Does the conjunctiva at the edge of the cornea appear normal or are there areas that are blanched white?

  Grade I injuries may have corneal epithelial damage but a clear cornea, no corneal opacity, and no limbal ischemia.

  These injuries generally carry a good prognosis for recovery. Irrigation and topical care are frequently the only required interventions.

  Grade II through IV injuries will have corneal haze or opacity and limbal ischemia.

  These injuries will have a guarded prognosis and will require more intensive treatment. Grading is determined by the most severe finding. For example, an eye with a clear cornea but showing limbal ischemia would be classified as grade II or higher.

Goals

Initiate eye irrigation as quickly as possible to reduce damage to the eye, treat the injury to prevent or reduce scarring and visual loss.

Minimum

- Immediate thorough irrigation to remove the chemical agent is the essential first step (IV fluid, sterile water, or clean water).
- Continue irrigation, using at least 2L of fluid.
- Use tetracaine eye drops as needed to facilitate irrigation (unpreserved lidocaine 2% can be substituted as eye drops if tetracaine is not available).
- Irrigation may not flush all chemical agents from the eye; examine for particulate matter and remove using a cotton tip applicator (CTA).
- Initiate pain control as needed. DO NOT use topical anesthetics for pain control; they significantly impair corneal healing.
- Initiate teleconsultation with photographs (include full facial views).

Figure 12. Grade II chemical injury with ischemia and epithelial defect.

Figure 13. Grade III chemical injury.

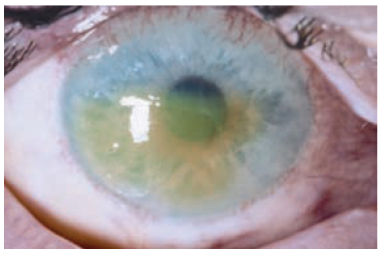
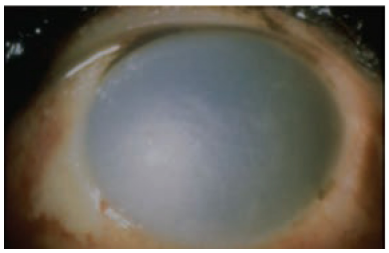


Figure 14. Grade IV chemical Injury.



Photographs by The University of Iowa and EyeRounds.org (12) and ©2017 American Academy of Ophthalmology, reprinted with permission. (13, 14).

Better

- Evaluate ocular pH using a urine test strip and CTA.
- Do not place the test strip directly on the eye. Roll a
- CTA across the conjunctival surface and then onto the test strip. If pH ≠ 7, continue irrigation and recheck until pH = 7.

Best:

- Initiate real-time video telemedicine consultation; treatment duration for more significant chemical burns will vary depending on the injury and are best determined by an eye-care specialist
- Further treatments and need for evacuation will be directed by the grade of injury. Evaluation will require fluorescein strips to evaluate the corneal epithelium and a light source, preferably with a red-free option (i.e. green lens), for evaluation of limbal ischemia.

Grade I:

- Topical antibiotic ointment (e.g., erythromycin ophthalmic ointment) 3 times per day Cycloplegic eye drop (cyclopentolate 1%), 1 drop every 8 hours, if available, for photophobia
- Preservative-free artificial tears 3 times per day, alternating between ointment treatments

Grades II–IV:

- Moxifloxacin 0.5% eye drops, 1 drop every 8 hours
- Topical corticosteroid (e.g., tobramycin/dexamethasone or prednisolone acetate 1%) 1 drop every hour while awake
- Cycloplegic drop (cyclopentolate 1%), 1 drop every 8 hours, if available
- Doxycycline 100mg PO every 12 hours; this has anti-inflammatory and anticollagenase benefits for the ocular surface.
- The following have been shown to improve corneal healing with severe chemical burns; add to the treatment if available:
  - Vitamin C 2g 4 times per day.[17]
  - Supplemental oxygen (administer 100% for 1 hour twice daily).[19] No data are available for the effectiveness of lower doses of oxygen.
- Reassess frequently until evacuation.
- No altitude restrictions for flight

7. PRESEPTAL AND ORBITAL CELLULITIS

Infection anterior to the orbital septum (usually involving the eyelid) is termed preseptal cellulitis. Preseptal cellulitis will present with tenderness, swelling, and erythema of the eyelids, with no orbital findings (e.g., no sign of proptosis, eye movement restriction, or change in vision). Preseptal cellulitis can generally be managed with oral antibiotics, but the possibility of methicillin resistant Staphylococcus aureus (MRSA) must be considered.

Infection in the orbit (posterior to the orbital septum) can occur as a result of adjacent sinusitis, skin infection, puncture wounds, or orbital foreign bodies. Multiple organisms, including staphylococcal, streptococcal, and gram-negative bacteria, are usually responsible. Orbital cellulitis has the potential to progress rapidly and may lead to irreversible loss of vision or intracranial extension. Orbital cellulitis presents with pain, proptosis, conjunctival injection, decreased vision, and loss of ocular mobility (which may cause double vision).

Goal

Recognize infection early and start oral antibiotics for preseptal cellulitis and IV antibiotics for orbital cellulitis. Evacuate to an eye surgeon as rapidly as possible if orbital cellulitis is suspected.

Preseptal cellulitis (Figure 15)

- Minimum
- Moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily.
- Does not cover MRSA; follow closely for worsening condition.
- Initiate pain control as needed.
- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.
- Initiate teleconsultation with photographs.

Best

Trimethoprim sulfamethoxazole DS 1 tablet PO every 8 hours combined with amoxicillin/clavulanic acid 875mg every 12 hours.

Orbital cellulitis (Figure 16)

Minimum

- Prompt recognition of the condition and the need for rapid intervention
- Initiate pain control as needed.
- Initiate IV access with broad-spectrum IV antibiotics: ertapenem 1g IV/IO daily or levofloxacin 500mg IV once a day.
- Initiate pain control as needed.
- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Initiate teleconsultation with photographs (include full facial views).

Figure 15. Preseptal cellulitis

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Figure 16. Orbital cellulitis

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Better

Nasal decongestants such as oxymetazoline (e.g., Afrin) nasal spray twice a day for 3 days (limit use to 3 days to prevent rebound effect); this will aid in draining of contributing sinusitis. Oral decongestants, such as pseudoephedrine 30mg every 6 hours, can be used if nasal spray is not available.

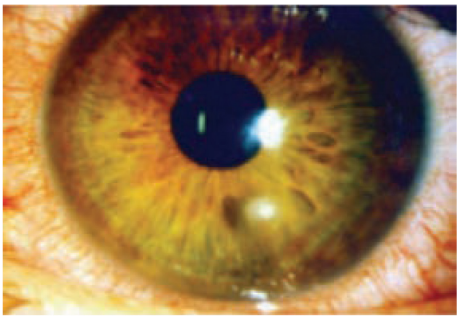
Best

- Initiate a detailed ocular examination.
- Monitor vision every 4 hours until evacuation (may take 24–36 hours to show improvement).
- Initiate real-time video telemedicine consultation.
- No altitude restrictions for flight

8. INFECTIOUS KERATITIS (CORNEAL ULCER)

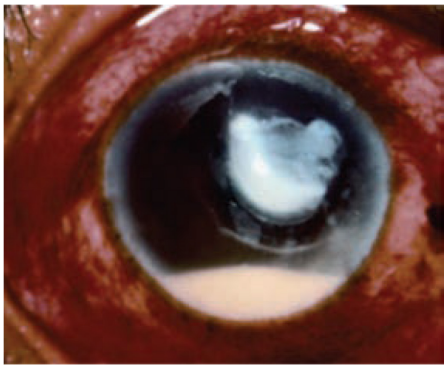
Infections in the cornea can lead to corneal scarring and permanent effects on vision (Figures 17 and 18). The most common risk factor for corneal ulcer is contact lens use.

Figure 17. Early corneal ulcer



Photograph courtesy of John D. Sheppard, MD, and Clelia Sheppard.)

Figure 18. Advanced corneal ulcer



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Goal

Early recognition and treatment to prevent long-term scarring of the cornea.

Minimum

- Moxifloxacin eye drops 1 drop every 15 minutes for the first 2 hours after diagnosis, then 1 drop every hour while awake
- Initiate pain control as needed. DO NOT use topical anesthetics for pain control; they significantly impair corneal healing.
- Initiate teleconsultation with photographs.
- Activate evacuation (goal is ophthalmic care within 24 hours if lesion is large, central, or affects vision).

Better

- Obtain a culture before beginning treatment for sight-threatening or severe keratitis with suspected infection, such as large central corneal infiltrate that extends to the middle to deep stroma.[20]

- Provide intense loading dose of moxifloxacin 0.5% eye drops 1 drop every 5–15 minutes for the first 30–60 minutes (patient can self-administer loading dose if reliable) after culture obtained.
- Treatment dose: 1 drop every 30–60 minutes around the clock until epithelial defect is closed.[20]
- Cycloplegic eye drop (cyclopentolate 1%), 1 drop every 8 hours for photophobia.

Best

- Real-time video telemedicine consultation
- Collagen corneal shield (national stock no. [NSN] 6515-01-482-9391) soaked in moxifloxacin drops for transport (generally 5–10 drops) and placed over the corneal infiltrate. This enables release of the medication to the ocular surface during transport, rather than administering repeated dosing.[21]
- No altitude restrictions for flight

NOTE: Topical steroid drops may be useful to reduce inflammation after the infection is controlled with topical antibiotics. Initiation of topical steroid drops should only be done under the direction of an eye care specialist after teleconsultation.

Herpes simplex virus (HSV) keratitis is an additional form of keratitis that usually occurs in patients with a history of previous episodes. HSV keratitis may demonstrate a specific dendritic staining pattern with fluorescein (Figure 19). After recognition, treatment can be initiated with oral acyclovir (400mg PO 5 times per day).

9. ANGLE -CLOSURE GLAUCOMA

Blockage of the normal flow of aqueous fluid in the anterior chamber of the eye will lead to increased IOP. If left untreated, blood flow to the posterior segment of the eye will be affected, leading to irreversible vision loss. The aqueous drain system can become blocked owing to anatomic variations, changes in lens size, inflammation, and trauma (Figure 20).

Figure 19. Dendrite staining with fluorescein in herpes simplex keratitis.

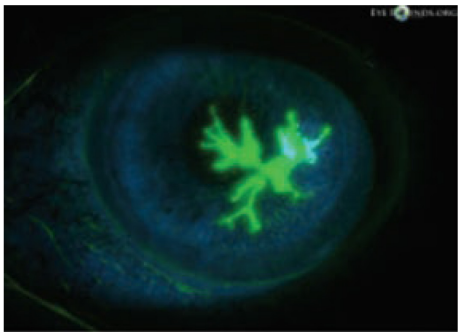

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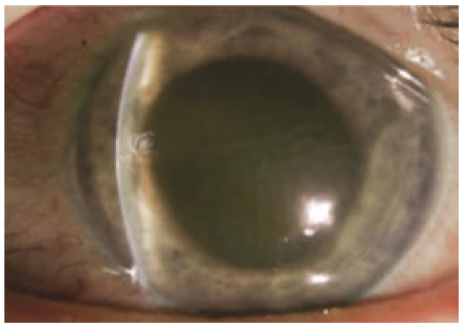
Figure 20. Angle-closure glaucoma



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Goals

- Prompt diagnosis and identification, lowering of IOP.
- Minimum
- Diagnosis
- Pain (often described as a deep pain, similar to tooth pain)
- Decrease in or loss of visual acuity

- Photophobia
- Dull or cloudy appearance of the cornea due to corneal edema
- Fixed, mid-dilated pupil (usually occurs after IOP reaches 30–40mmHg)
- Increased IOP by palpation
- Acetazolamide 500mg PO initial dose, then 250mg PO every 4 hours to decrease IOP. (***Note***: contraindicated in patients with sickle cell trait.)

Initiate teleconsultation with photographs.

- Activate evacuation with goal of evaluation by an eye surgeon within 24 hours.

Better

- Oral acetazolamide plus topical IOP-lowering eye drops (timolol 0.5%, 1 drop twice a day in the affected eye).
- Administer antiemetics as required by patient symptoms (ondansetron 4mg ODT/IV/IO/IM every 8 hours as needed).

Best

- Topical corticosteroids (prednisolone acetate 1%) 1 drop every hour after consultation with ophthalmology or optometry.
- 3% hypertonic saline 250mL IV or mannitol 1g/kg over 30–60 minutes can be used to decease IOP if the aforementioned interventions are not effective.[9]

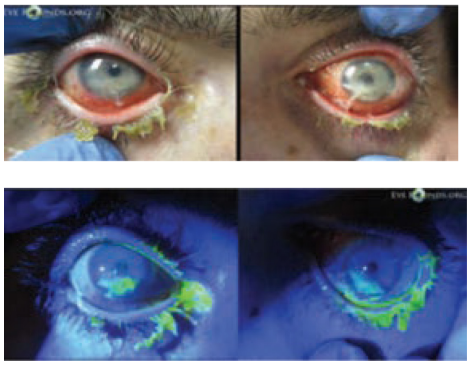
10. EYE CARE IN THE MULTITRAUMA / THERMAL BURN PATIENT

Patients with multisystem trauma who are intubated and sedated are at risk of developing corneal complications due to metabolic derangements and impaired ocular protective mechanisms.[22] The presence of thermal facial burns puts the patient at high risk for exposure keratopathy. Loss of the normal blink reflex, impaired tear production, abnormal tear film dynamics, and incomplete eyelid closure, combined with the inability to relay ocular complaints all contribute to the development of exposure keratopathy and increase the risk for infectious keratitis.[23] If there is no concern for OGI, ultrasound examination may be performed if personnel are equipped and trained. Patients with head and facial burns with eyelid involvement are especially prone to entropion (with burned eyelash stubs abrading the cornea) as well as exposure keratopathy from scar-related lid retraction and proptosis from orbital congestion (Figures 21 and 22).

Figure 21. Extensive facial burns with lid contraction and orbital congestion.

Photograph by COL Mark Reynalds

Figure 22. (A) Exposure keratopathy; (B) with fluorescein staining.



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Goal

Prevent ocular exposure and corneal injury in high risk patients.

Minimum

Initiate ocular surface protection with sterile petrolatum or methylcellulose drops to keep the ocular surface from drying out. (Do not substitute a nonophthalmic lubricant).

For thermal facial burns, instill erythromycin ophthalmic ointment or sterile petrolatum every 2 to 4 hours.

Better

Gentle horizontal taping of lids with hypoallergenic tape in conjunction with ocular surface protection to protect the eyes.[24]

Evaluate the eyes and instill a surface protectant at least every 8 hours. Ensure the surface of the eye is not dry, there is no pressure on the eye, pupil reactivity has not changed, and the eyelids are completely closed to protect the eye.

Best

- Detailed ocular evaluation
- Cover eyes with polyethylene film to prevent drying.
- Food-grade film is safe for use around the eyes.
- Apply from the eyebrow to the maxilla to ensure proper coverage
- No altitude restrictions for flight

NOTE: Surgilube should never be instilled into the eye as a lubricant, because if can cause corneal toxicity.[18] When used for ultrasound examination, place a thin film (e.g., food-grade polyethylene or Tegaderm [3M, http://www.3m. com]) over the closed eyelid.

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APPENDIX A: RELATIVE AFFERENT PUPILLARY DEFECT

Afferent Pupillary Defect

Injury to or disease of the optic nerve or retina will affect pupillary function. Under normal conditions, the pupils will react equally to light through the consensual pupillary reflex.

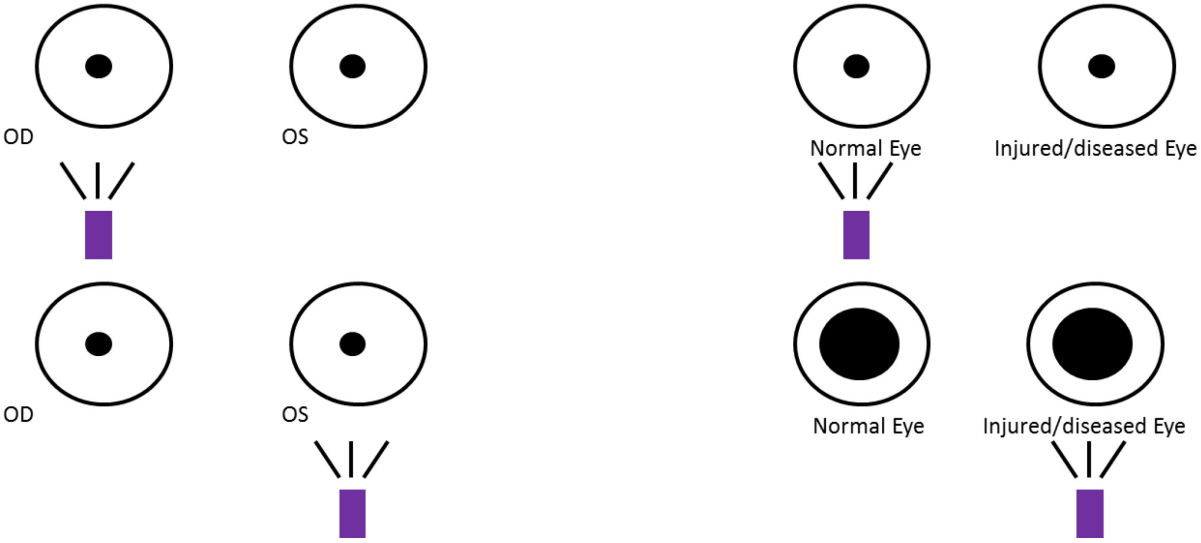
Equipment: Bright light source

Technique: Shine light into one eye and note pupillary response; swing light to opposite eye and observe response (expect equal constriction)

Abnormal Result: When swinging light source to injured/diseased eye, there will be a dilation of the pupils; this is due to the injured/diseased eye perceiving less light than the unaffected eye.

Significance: Allows for evaluation of visual pathways, even in unconscious patient

Common Causes: Retrobulbar hemorrhage, retinal detachment, traumatic optic neuropathy, advanced glaucoma



APPENDIX B: USE OF THE DIRECT OPTHALMOSCOPE

The direct ophthalmoscope is designed to use the patient's own optical system to magnify the optic disc and retina for diagnostic purposes, but it has multiple additional uses, such as obtaining a magnified view of the anterior segment, evaluating for visually significant cataract, and evaluating pupil responses in uncooperative or pediatric patients.

Equipment: Direct Ophthalmoscope

Techniques:

- To obtain a magnified view of the anterior segment of the eye. Viewing from 2-3 inches from the eye using the plus lenses (black or green numbers, ~5) will provide an enlarged view when evaluating for foreign bodies or corneal abrasions. Using the cobalt blue filter with fluorescein dye will enhance the view of corneal epithelial defects.
- To evaluate for cataracts, stand approximately 1 meter from the patient and evaluate the red reflex from the retina with no lens dialed in (no red or green numbers). Blockage of the red reflex will highlight any visually significant cataracts.
- To check for pupil reactivity in uncooperative patients or children, view the red reflex from 2-3 feet (again with no lenses dialed in); movie the light from one eye to the other and observe the change in the size of the red reflex.
- Assessment of retinal spontaneous venous pulsations may be possible in the setting of traumatic brain injury.[25]

APPENDIX C: BASIC OCULAR EXAMINATION

Basic Ocular Examination

Visual acuity → **Right** / **Left**

Measure with glasses in place (if available); record from chart or use card at 16 inches

- For vision less than 20/400, assess Finger Counting (FC) at 5 ft and 2 ft
- For vision less than finger counting, assess Hand Motion (HM) at 1 ft
- For vision less than Hand Motion, assess for Light Perception or No Light Perception
- Record with right eye (OD) on top, left eye (OS) on bottom

IOP:

Intraocular Pressure (T_{palp}): measure by palpation

- Normal range 10-21 mmHg
- Use 2 fingers to palpate eye through CLOSED lids
- Should feel similar to tennis ball (use other eye for comparison)
- Elevated intraocluar pressure (such as in Acute Angle Closure Glaucoma or Retrobulbar hemorrhage) will feel much firmer (like palpating over eyebrow)

Lids: Lesions, lacerations, edema, erythema, drooping (ptosis)

Conjunctiva/Sclera: Hyperemia(injection), discharge, injuries, masses, abnormal pigmentation

Cornea: Opacities, ulcerations, abrasions, foreign bodies, lacerations

Anterior Chamber: Approximate depth (shallow or deep), visible foreign bodies

Iris/Pupil: Reaction to light (direct and consensual) abnormal shape of pupil, iris abnormalities

Lens: Lens opacity (cataract)

Fundus: Abnormalities such as blood, scarring, papilledema, abnormal cupping of disc

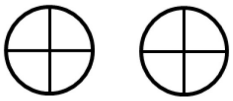
Assessment: Diagnosis, treatment and follow-up plan

EOM:

Extraocular Muscle Evaluation (EOM): assess eye movements in all fields of gaze

- Ask patient to follow your finger (without moving the head)
- Record any restrictions to movement

Vf_c:



Right **Left**

Visual Fields by Confrontation (Vf_c): evaluate limitations in the field of vision

- Sit/stand facing the patient , if testing the patient's right eye, close your left eye
- Present fingers to both sides of visual field simultaneously (generally 1 finger with one hand, 2 fingers with the other)
- Ask patient how many fingers they can see
- Record areas of visual field loss as seen from patient's perspective.

APPENDIX D: PACKING AND PLANNING CONSIDERATIONS

Level	Equipment	Medications
Minimum	Rigid Eye shield	Moxifloxacin 400 mg oral tablets or Levofloxacin 750 mg oral tablets
	Lateral canthotomy/cantholysis instrument set	Clindamycin 300 mg oral tablets
	Bright light source	Ketamine IV
	Visual acuity estimate reference	Odansetron oral dissolving tablets or IV
	Teleconsultation capability	Tetracaine eye drops or 2% lidocaine without epinephrine (unpreserved)
		Fluid for ocular irrigation
		Fluorescein ophthalmic stain
Better	Ice packs	IV ertapenem 1 gm
	Direct ophthalmoscope	Oxymetazoline HCL nasal spray
	Hypoallergenic tape	Erythromycin ophthalmic ointment
		Cyclopentolate hydrochloride 1% eye drops
		Moxifloxacin 0.5% ophthalmic drops
Best	Collgen eye shields (NSN 6515-01-482-9391)	Mannitol IV
	Steristrips	Acetazolamide 250mg oral tablets
	Polyethylene film (food grade)	Corticosteroids IV
	Oxygen source	Timolol 0.5% eye drops
	Urine test strips	Prednisolone acetate 1% eye drops
	Portable ultrasound with linear probe	Preservative-free artificial tears
		Tobramycin/dexamethasone combination eye drops (tobradex)
		Acyclovir 400 mg oral tablets
		Vitamin C
		Tetanus vaccine
		Human rabies immune globulin and rabies vaccine

APPENDIX E: OCULAR INJURIES & VISION THREATENING CONDITIONS SUMMARY TABLE

Eye Care Goals	
• Maintain high suspicion for ocular injuries. • Assess and document visual function. • Examine for critical physical findings. • Maintain patient comfort and prevent further injury (e.g., pain medication, anti-emetic, eye shield, elevate head 30º-45º). • Establish telemedicine contact with eye care specialist; provide photographs or real-time video. • For eyesight-threating conditions, prioritize evacuation with goal to arrive at an eye surgeon or eye specialist within 24 hours. • Provide optimal Role 1 care when evacuation goal cannot be met	
Open globe injury/suspected open globe	
Goal	Prevent further damage to the eye, prevent infection in the eye (endophthalmitis), and evacuate to an eye surgeon as soon as possible.
Minimum	Rigid shield, pain control, antiemetic, raise head 30º-45 º. Antibiotic prophylaxis: moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily or ertapenem 1g IV/IO daily.
Better	Add clindamycin 300 mg PO or IV/IO every 8 hours to endophthalmitis prophylaxis.
Best	Detailed ocular exam every 4 hours. Coordinate surgical care within 8 hours of injury.
Ultrasound is contraindicated for suspected OGI because it places pressure on the eye.	
Retrobulbar hemorrhage/orbital compartment syndrome (OCS)	
Goal	Lower the orbital compartment pressure as soon as possible to prevent tissue damage.
Minimum	Prompt recognition (i.e., bulging of eye, increased pressure by palpation, decreased vision, +RAPD). Lateral canthotomy/cantholysis (LCC) within 90 minutes of injury (if evacuation to surgical capability will take more than 60 minutes). Pain control, antiemetic, raise head 30º-45 º.
Better	Minimize patient movement, ice packs, monitor for return of increased intraorbital pressure (IOP).
Best	If rebleeding after initial response to lateral canthotomy/cantholysis, acetazolamide 500mg PO once then 250mg PO 4 times per day. If unable to take PO, 3% hypertonic saline 250ml IV or mannitol 1 g/kg IV over 30-60 minutes. Corticosteroid (e.g. 1g methylprednisolone IV once).
Relative afferent pupilary defect (RAPD), abnormal dilation of pupil when light is shined into injured eye. LCC is a vision-saving procedure with minimal risk of causing additional ocular injury. When in doubt, perform LCC.	
Closed globe injury (caused by blunt trauma)	
Goal	Identify significant ocular injuries; protect the eye from further injury.
Minimum	Document vision, pain control. Prevent further damage with rigid shield, anti-emetic, raise head 30º-45º.
Best	**Hyphema (anterior chamber injury):** Topical steroid eye drop (prednisolone acetate 1% 4 times per day) and cycloplegic drop (cyclopentolate 1% 1 drop every 8 hours). Monitor vision and IOP. Treat elevated IOP with timolol eye drops 0.5%, 1 drop twice a day or acetazolamide 500mg PO once then 250mg po 4 times per day. (Note: contraindicated in patients with sickle cell trait). If unable to take PO, 3% hypertonic saline 250ml IV or mannitol 1 g/kg IV over 30-60 minutes.
	Retina/optic nerve (posterior chamber injury): Supplemental oxygen. Perform careful ultrasound and transmit images with telemedicine consult.

Eyelid laceration	
Goal	Prevent infection, protect the eye from further injury.
Minimum	Maintain high suspicion for open globe injury (treat as such if suspected). Keep injured eyelid tissue moist by covering with polyethylene film (food grade).
Better	For foreign body penetration, animal bite, or laceration with visible orbital fat, start antibiotic: moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily or amoxicillin/clavulanic acid 875mg/125mg PO every twelve hours or ertapenam 1 gm IV/IO daily.
Best	Detailed ocular exam. Irrigate and perform temporary closure of wounds. Tetanus and rabies prophylaxis if indicated.
Orbital fracture	
Goal	Evaluate for concurrent open or closed globe injury and prevent long-term complications.
Minimum	Maintain high suspicion for open globe injury. No nose blowing. Pain control, antiemetic, raise head 30º-45º.
Better	Antibiotic moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily or amoxicillin/clavulanic acid 875mg/125mg PO every twelve hours or ertapenam 1 gm IV/IO daily. Initiate nasal decongestant (e.g., Afrin nasal spray twice a day for 3 days) or oral decongestant (e.g., pseudoephedrine 30mg every 6 hours).
Best	Detailed ocular exam. Ice pack for 20 min every 1-2 hours for first 48 hours. Monitor for delayed onset of OCS requiring LCC.
Chemical injuries	
Goal	Initiate eye irrigation as quickly as possible to reduce damage to the eye, treat the injury to minimize scarring and loss of vision.
Minimum	Immediate irrigation with IV fluid, sterile water, or clean water with at least 2L of fluid. Remove any particulate matter using a cotton tip applicator.
Better	Continue irrigation until pH=7, verified using urine test strip.
Best	Grade I - erythromycin ophthalmic ointment, cyloplegic drops (cyclopentolate 1%), lubrication with artificial tears.
	Grade II-IV - topical antibiotic drops (moxifloxacin 0.5% eye drops, 1 drop every 8 hours), topical corticosteroid (tobradex or prednisolone acetate 1%, 1 drop every hour while awake), doxycycline 100 mg po every 12 hours, Vitamin C 2g 4 times per day, 100% O_2 for 1hr twice daily.
Preseptal and orbital cellulitis	
Goal	Recognize infection early and start appropriate antibiotics; evacuate suspected cases of orbital cellulitis to an eye surgeon as rapidly as possible
Minimum	**Preseptal**: Moxifloxacin 400mg PO daily or levofloxacin 750mg PO daily. Does not cover methicillin-resistant *Staphylococcus aureus* (MRSA); follow closely for worsening condition. **Orbital**: IV antibiotics: ertapenem, 1 g IV/IO daily or levofloxacin 500mg IV once a day.
Better	**Orbital**: Add nasal decongestant (e.g. Afrin nasal spray twice a day for 3 days) or oral decongestant (e.g., pseudoephedrine 30mg every 6 hours).
Best	**Preseptal**: Trimethoprim sulfamethoxazole DS 1 tablet PO every 8 hours combined with amoxicillin/clavulanic acid 875mg every 12 hours. **Orbital**: Continue IV antibiotics. Monitor vision every 4 hours until evacuation.
Infectious keratitis	
Goal	Prompt recognition and treatment to minimize scarring and loss of vision.
Minimum	Moxifloxacin eye drops 1 drop every 15 minutes for first 2 hours, then 1 drop every hour while awake.
Better	Obtain a culture prior to beginning treatment for sight-threatening keratitis; intense loading dose of moxifloxacin 0.5% eye drops 1 drop every 5-15 min for the first 30-60 minutes (patient can self-administer loading dose if reliable) after culture obtained; then 1 drop every 30-60 minutes around the clock until epithelial defect is closed; cycloplegic eye drop (cyclopentolate 1%), 1 drop every 8 hours for photophobia.
Best	Collagen corneal shield soaked in moxifloxacin drops for transport (5-10 drops) placed over the corneal infiltrate.

Angle-closure glaucoma	
Goal	Prompt recognition and treatment to decrease intraocular pressure.
Minimum	Diagnose based on signs and symptoms: pain, decreased vision, photophobia, dull or cloudy cornea, fixed mid-dilated pupil, increased IOP by palpation. Acetazolamide 500 mg PO initial dose, then 250mg PO every 4 hours to decrease IOP.
Better	Oral acetazolamide plus topical IOP-lowering eye drops (timolol 0.5%, 1 drop twice a day in the affected eye), antiemetic as needed.
Best	Topical corticosteroid (prednisolone acetate 1%) 1 drop every hour after consultation with eye specialist. IV medication for refractory cases (3% hypertonic saline 250ml IV or mannitol 1 g/kg over 30-60 min).
Multi-trauma/thermal burn	
Goal	Prevent ocular exposure and corneal injury in high-risk patients.
Minimum	Keep the ocular surface from drying out using lubricants: sterile petrolatum or methylcellulose drops (do not substitute a non-ophthalmic lubricant). For burns, erythromycin ophthalmic ointment or sterile petrolatum every 2-4 hours.
Better	Horizontal taping of eyelids to protect eyes. Evaluate the eyes and instill a lubricant every 8 hours.
Best	Conduct a detailed ocular exam and cover eyes with food grade polyethylene film to protect eyes.
Surgilube should never be instilled into the eye as a lubricant due to corneal toxicity. When used for ultrasound examination, place a thin film over the closed eyelid.	

APPENDIX F: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Orthopaedic Trauma: Extremity Fractures (CPG ID:56)

This guide describes the initial non-surgical and surgical management of extremity fractures and to define care guidelines for fractures of upper and lower extremities.

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GOALS

The purpose of this CPG is to describe the initial non-surgical and surgical management of extremity fractures; to demonstrate appropriate application of an external fixator with limited resources in order to stabilize for transport; and to define care guidelines for fractures of upper and lower extremities in the context of the host nation's environment and the options available to different patient groups.

BACKGROUND

The majority of combat casualties sustain musculoskeletal injuries[1,2] and the treatment of fractures and associated soft tissue wounds comprise the majority of Role 2 and 3 orthopaedic procedures.[3] The prevalence of musculoskeletal injury requires that surgeons caring for victims of war must manage extremity fractures in the austere environment. Prior to the development of long bone stabilization, mortality from isolated femur fractures was 87% in WWI and reduced to <8% with appropriate splinting. During the recent conflicts, especially as surgical teams have gotten smaller and more dispersed, long bone extremity fracture stabilization will occasionally take second precedent to other injuries. The cumulative burden of femur fractures can make polytrauma patients sicker; so while resources such as imaging may be limited, early femur stabilization is critical for the overall outcomes. Appropriate wound management and fracture stabilization are the mainstays of treatment and are a critical aspect of the multidisciplinary treatment of combat casualties. While a patient's overall physiology and associated wounds must be considered, the effective stabilization of long bone fractures and appropriate debridement of soft tissue injury contribute to effective resuscitation.

EVALUATION AND TREATMENT

EARLY AND THOROUGH WOUND DEBRIDEMENT

- Prehospital care of extremity wounds is covered in the Tactical Combat Casualty Care guidelines and in the Acute Traumatic Wound Management in Prolonged Field Care CPG, 24 Jul 2017. In general, suspected fractures should be splinted whenever possible once life-threatening injuries have been addressed. Open wounds should be treated as soon as possible with antibiotics; either oral or IV antibiotics are acceptable depending on the situation and the patient's ability to swallow the medication. Traction splints may be utilized for femur fractures, however, are not required and other splinting methods may be more expedient. A pelvic binder is indicated in cases of severe lower extremity injury and may be utilized in conjunction with a traction splint.
- Far-forward medical facilities may not have the capability to perform surgical debridement, but early irrigation with removal of gross contaminants may be possible at any level of care and should be performed as soon as possible after injury.
- During the initial examination, the neurologic and vascular exam of the affected extremities should be carefully documented and the affected extremity evaluated for signs of acute compartment syndrome (ACS). Accurate documentation for the next role of care is necessary to determine any evolution of ACS or neurovascular injury.
- A thorough irrigation and surgical debridement should be performed as early as possible.[4]
  - Remove debris and devitalized tissue.

- Bone fragments without soft tissue attachment (i.e. muscle, periosteum) or that are easily removed, should be excised with the exception of large articular fragments.
- All viable tissue should be preserved in order to afford receiving physicians the greatest number of reconstructive options.
- Tag transected nerves and tendons to facilitate identification of structures during reconstruction.
- Treat open fractures with prophylactic antibiotics, primarily 1st generation cephalosporin and tetanus toxoid as soon as possible.[5-9] While there currently is no evidence to support broader spectrum antibiotics, Gram negative organisms are commonly cultured initially and during the treatment of subsequent infection.[10] The use of topical antibiotics is becoming more prevalent and has been shown effective in preventing subsequent infection.[11]

FRACTURE STABILIZATION

1. Fracture instability, especially long bone, can compromise effective patient resuscitation due to ongoing hemorrhage, continued soft tissue damage and respiratory splinting from increased pain. This leads to increased cytokine release, inflammatory response, and shock.[12-15] Early stabilization of femoral shaft fractures is associated with decreased pulmonary complications (including acute respiratory distress syndrome), ICU time, hospital days and mortality and others.[16-19] Long bone stabilization is an important part of early damage control surgery by stabilizing both anatomy and physiology, and is required in the setting of a temporary shunting or definitive vascular repair. Splinting may be the only far-forward option for fracture stabilization and affords the receiving surgeon the greatest number of surgical options. Splinting also may be the most appropriate intervention for low energy fractures and those in the upper extremity and distal lower extremity such as wrist, hand, humerus, elbow, ankle, and foot fractures. An appropriate splint can be effective in temporizing any suspected or known fracture or soft tissue injury until more appropriate stabilization or imaging is available.

2. Open wounds should be addressed first and the status of the underlying wound as well as the date and time of the most recent debridement and irrigation should be documented on the splint itself. If the patient is to be transported, splints must be suitable for the mode of transportation and acceptable within limits of passenger space. Caution should be utilized so splints are not constrictive/circumferential or predispose to compartment syndrome, especially prior to long evacuations. Splints should immobilize the joint above and below the fracture and should have adequate padding at pressure points to prevent soft tissue injury. Splints are intended to limit further injury and are not meant to be definitive treatment. Anatomic reduction may not be possible or necessary for initial splinting of fractures, but a restoration of overall length and alignment of the limb should be sought. A neurovascular exam, including assessing for compartment syndrome, should be documented pre- and post-splinting with or without reduction attempts, to confirm that perfusion and function remain intact after fracture manipulation.

3. Finger and hand injuries may be immobilized with standard splinting methods. Forearm and elbow injuries are best splinted with a long arm posterior splint or a sugar-tong splint. Humerus and shoulder fractures are best immobilized using a sling and swathe or coaptation splint, ensuring there is enough padding at the axilla. Long leg splints for tibia fractures and below the knee splints for

ankle and foot fractures provide adequate stability for transport. Ensure the splint padding allows access for limb compartment.

EXTERNAL FIXATION

1. Due to logistical constraints and concern for infection, internal fixation is not recommended in most austere settings where evacuation to higher levels of care is possible. Surgeons should be well versed on external fixator placement for long bone and periarticular fractures.

   In the setting of concomitant vascular injuries requiring repair or shunting, the orthopaedic surgeon and general surgeon should discuss the sequence of external fixation application (before or after the vascular procedure) considering the following:

   - Ischemia time
   - Degree of deformity in the fractured extremity, specifically the amount of shortening, angulation, mal-rotation, and instability across the fracture site
   - Surgeon comfort level and experience affecting speed of external fixation application
   - Indications to proceed directly to arterial repair versus need for initial shunting

   Benefits of early vascular shunting or repair include reduced ischemia time and possibly reduced need for distal limb fasciotomies, while early fracture stabilization helps re-establish limb and vascular length across the site of injury as well as restore tissue planes for dissection and exposure. The treating surgeons should be mindful of the effects of restoring limb length and alignment on the vascular shunt/repair and plan their interventions to avoid disruption of restored blood flow while effectively stabilizing the limb.

2. External fixation affords adequate fracture stabilization to minimize additional soft tissue trauma and can provide easier access for wound care and re-evaluation for neurovascular injury and ACS. Early fracture stabilization may blunt inflammatory mediators associated with fractures in poly-trauma[12,18] and can be rapidly applied in the multiple injured patient or in a mass casualty situation. Stability afforded by external fixation is also beneficial for pain control and ease of transport, and minimizes the need to manipulate the injured limb during transport and at each higher role of care.

3. External fixation in the austere environment is performed within the constraints of limited equipment and the lack of available fluoroscopy. Surgeons should be familiar with extremity bone and neurovascular anatomy in order to safely apply an external fixator for initial stabilization without the aid of fluoroscopy. Otherwise, splinting should be used for temporary stabilization. Specific portable external fixation kits designed for military use include self-drilling and self-tapping pins that use hand-powered drills for advancement into the bone. External fixation has been shown to be safe in the austere environment when performed at Role 2 and Role 3 facilities.[20] However, caution is advised in attempting external fixation when no basic radiographic imaging is available to identify the fracture pattern, particularly for closed fractures where the facture pattern cannot be visualized or palpated through an open wound. In this case the limb should be splinted without traction and the patient moved to a level of care that has X-Ray capability.

4. External fixator stability is improved by increasing bony apposition at the fracture site, placing the connecting bars as close to the skin as is deemed safe, increasing the distance between pins in each fracture fragment, and using the largest diameter pin possible (typically, 5.0 mm pins in long bones).

Two appropriately placed pins; above and below fracture fragment should provide sufficient stability and will allow receiving surgeons the most options for definitive fixation. Consider the skin incisions for future internal fixation plans when choosing pin sites.

5. The following guidelines allow the safe and effective placement of fixation pins in the austere environment, without the assistance of fluoroscopy but with some basic imaging of the fracture pattern available prior to pin placement.[21] Pins should be placed both "near and far" from the fracture in both major bone fragments. The fracture ends in a closed fracture can be estimated by palpation/manipulation of the bone. One pin in each main fracture fragment should be placed typically 2-3 cm away from the fracture end to improve stability. Pins placed too near the fracture can decrease the external fixator's ability to maintain stability if the pin only captures one bone cortex or is placed in fracture lines that are not grossly apparent. To place each pin, make a longitudinal incision approximately 1 cm in length at the planned pin site and bluntly dissect down to bone. The incision should be generous enough to accommodate the entire width of the pin, as trapped or tented skin contributes to skin irritation and pin tract infection, ultimately leading to pin loosening. Load the pin in either a powered drill or manual driver and place the pin into the incision until the pin meets bone. The pin tip can be used to palpate the edges or curve of the bone so that the central portion may be identified. After broaching the near cortex, hand advancement of the pin should be used to allow the surgeon to feel the far cortex, which is identified by encountering increased resistance while turning the pin. Engaging pin threads across the far cortex provides ideal stability. If intraoperative imaging is available, pins should be advanced until the drill tip is fully past the far cortex. If fluoroscopy is not available, manual advancement 6-8 full turns after reaching the inner surface the far cortex should provide sufficient engagement of the pin. Surgeons must always be aware of limb anatomy as excessive pin advancement can put neurovascular structures at risk.

6. The "far" pins should be placed as far from the fracture site as deemed safe. Intercalary fragments of segmental long bone fractures typically do not require pin fixation, and single pin fixation in these smaller fragments likely does not add to construct stability. Clamps designed to connect the pins and bars are available in the equipment sets, and the pin clamp may be used as a drill guide for appropriate placement of incisions between pin sites. However, using these clamps limits the potential distance between pins in a fracture segment and off-axis pins may not engage in the clamp sufficiently to the detriment of construct stability. External fixators may be placed to span joints if the fractures is near a joint or extends into the articular surface (knee, elbow). (Figures 1, 5, 6)

7. After placing pins, the pins in each fragment can be secured to each other with a pin clamp and tightened. Modified bars are then secured into each pin clamp, and long bars connect to the modified bars of each pin clamp/fracture fragment by using "bar-to-bar" connectors. One bar spanning each fracture fragment is often sufficient for fracture stability. If bar length is too short to span the fracture site, then 2 bars can be connected by a "bar-to-bar" clamp to gain the necessary length. The overall goal of any construct is to restore length and overall alignment of the limb by establishing a provisional reduction of the fracture (thus improving stability), reduce intracompartmental volume to allow tamponade of bleeding, and to restore vascular flow by "unkinking" vessels. Without fluoroscopy, simple longitudinal traction while grossly restoring coronal and sagittal alignment is sufficient for initial stabilization. When spanning the knee, the fixator should be tightened with slight knee flexion. (See Figure 1 below.)

8. Pins can be dressed with Xeroform or similar material and gauze, with Kerlex wrapping of the pins to provide stability to the skin. No formal pin care is recommended, especially in this acute phase, as

formal cleaning protocols have failed to demonstrate improvement in pain, stability, or complications.[22]

Figure 1. Spanning external fixation across the knee joint

LOWER EXTREMITY

Femur: Given the medial and posterior location of neurovascular structures in the thigh, an anterolateral or lateral approach can be used with little risk to neurovascular structures. At the distal third of the femur, however, care should to be taken to avoid over-penetration of the posterior cortex, as this risks injury to the popliteal artery. Anterior pins placed in the distal femur should begin 7.5 cm above the superior pole of the patella to avoid inadvertent intraarticular placement.[23]

Figure 2a. Femur pin

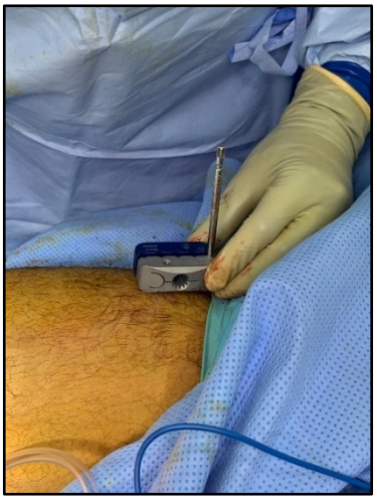
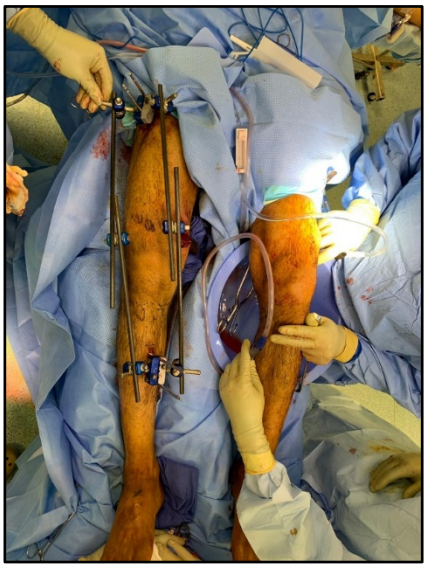


Figure 2b. Knee spanning fixator of right knee.



Knee: For distal femur and/or proximal tibia fractures including those involving the articular surfaces, a knee spanning fixator is most appropriate. Two pins each in the intact femur and tibia can be connected by bars. To maximize stability of this longer construct, good pin spread and/or multiple bars should be considered. As with other long bone fractures, longitudinal traction is used to correct coronal and

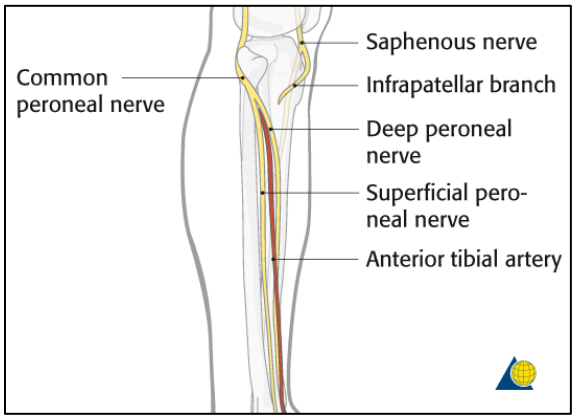
sagittal alignment. The fixator should be locked with the knee in flexion. A posterior slab, short leg splint can be helpful to control ankle plantarflexion and provide additional soft tissue rest and pain control as the gastrocnemius muscle crosses the knee joint.

Tibia: The neurovascular bundle runs along the bone's posterolateral surface. This leaves the anteromedial surface free for safe pin placement. The thin layer of subcutaneous tissue overlying the bone makes this surface easily palpable along its entire length. The direct anterior tibial crest should be avoided as it is significantly thicker than the rest of the bone, and pin placement is difficult even with a power drill. Pins should be placed about 1 cm medial to the anterior crest to avoid the crest as excessive drilling can result in thermal necrosis, pin loosening and eventual infection.

Figure 3. Tibial pin placement

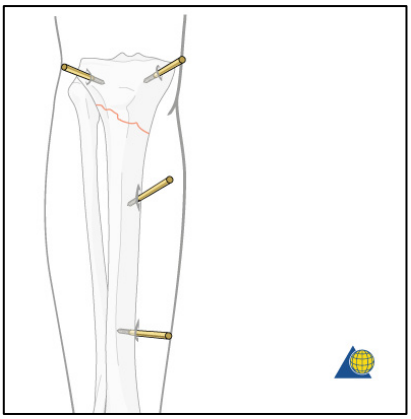
Figure 3a. External view of tibia pin placement

Figure 3d. Lateral view of tibia



Lateral view of tibia showing location of neurovascular structures to avoid during tibial pin placement. Structures are posterolateral and are easily avoided with placement of pins on anteromedial face of tibia.

Figure 3e. Anterior view of tibia with pins



Anterior view of tibia showing potential pin placement for a proximal tibia fracture. A knee-spanning fixator is also an appropriate option in this case.

Source: Courtesy of Marcel Erismann, Senior Medical Illustrator, AO Foundation

Fibula: External fixation of the fibula is not indicated despite any amount of associated tibia or soft tissue injury.

Ankle: To stabilize the ankle (typically in the setting of an unstable distal tibia fracture), two pins should be placed in the tibia proximal to the fracture site and be connected to a centrally-threaded

transfixation pin (or pins) placed through the calcaneus using a medial-to-lateral approach to avoid injury to the neurovascular bundle located just posterior to the medial malleolus. (Figure 4a below) While a 4 mm pin can be placed in the first metatarsal to control ankle dorsiflexion, stable placement can be difficult and the tibialis anterior tendon at the base of the bone can be at risk. A calcaneal pin is more easily placed, and sufficient ankle dorsiflexion can be maintained with the addition of a posterior slab splint as necessary. Talar neck pins, with appropriate anatomic knowledge, can be useful to stabilize the distal tibia, particularly if a calcaneal fracture is present that precludes transfixation pin placement.

Figure 4a: Pin placement for ankle stabilization

Source: Courtesy of Marcel Erismann, Senior Medical Illustrator, AO Foundation

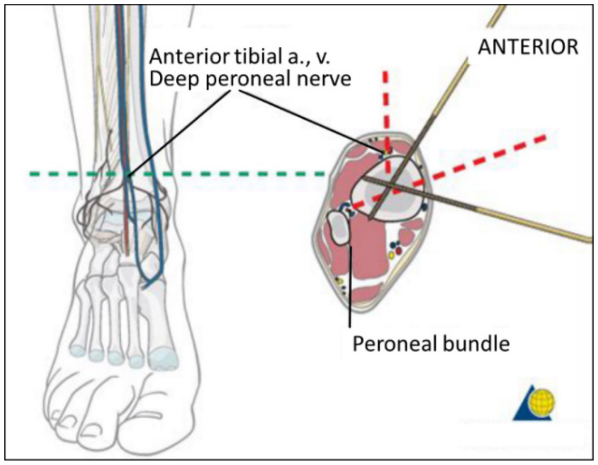


Figure 4b. Delta frame

Example of an ankle-spanning "delta frame" with 2 transfixation calcaneal pins necessary to connect bars to the pin clamps when no pin-to-bar connectors available. Two pins may lessen the need for a posterior splint but a splint can be useful for additional soft tissue protection and to prevent forefoot plantarflexion. Note the addition of the two short "kickstand" bars posteriorly that decreases direct pressure on the heel.

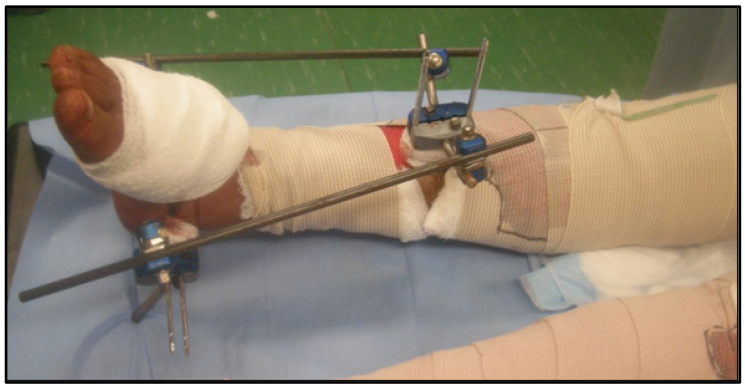


Figure 5. Use of spanning external fixation to stabilize blast injury to lower extremity

Basic radiographic imaging obtained prior to procedure demonstrated comminuted distal 1/3 femoral and mid-shaft tibial fractures. A spanning external fixator was placed across the knee joint, and an expanded "delta frame" external fixator uses the proximal tibial pin clamp site to stabilize the segmental tibial fracture.

Figure 5a: Comminuted distal femoral fracture

Figure 5b: Mid-shaft tibial fractures

Figure 5c: External fixator

Figure 5d: Delta frame external fixator

UPPER EXTREMITY

Splinting of the upper extremity may be preferable over external fixation especially for isolated injuries. Upper extremity external fixators can be complicated by the proximity of neurovascular structures. Familiarity with upper extremity anatomy and careful dissection before pin placement can lessen the chance of injury.

Humerus: External fixation of the humerus can be particularly risky due to the intimate relationship with the neurovascular structures. External fixation should be reserved for instances of severe soft-tissue destruction or when associated vascular injury requires shunting or repair. In general, the lateral and anterior surfaces are safer for half pin insertion. Over-penetration of the medial cortex places the neurovascular bundle at risk for injury. For fixation around the elbow, half pins are placed proximal to the lateral epicondyle through an open approach. The incision should be of sufficient length to positively identify the radial nerve as it traverses anteriorly between the biceps and brachioradialis about 10-14 cm proximal to the lateral epicondyle. After pin placement, the incision is closed around the pins.

Ulna: The dorsal surface of the ulna is easily palpable along its entire length. The ulnar nerve is located radial and volar to the bone making the palpable surface an ideal site for pin placement. 5mm pin diameters can be too large based on the diameter of the bone, and 3-4mm pins should be used instead.

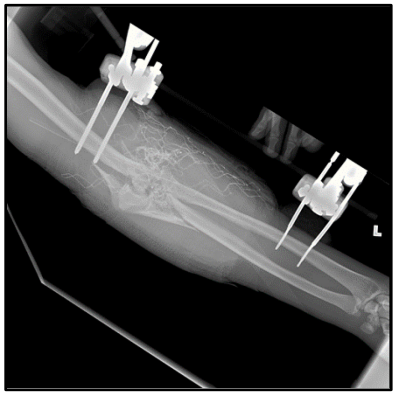
Radius: At the proximal third of the radius, the dorsal surface is obscured by the variable course of the posterior interosseous nerve. Accordingly, pin placement should be limited to the radial surface of the more palpable middle and distal third of the radius to avoid injuring the radial nerve motor branches. An incision allowing sufficient dissection to expose and retract the branches of the superficial branch of the radial nerve and underlying tendons is necessary to avoid entrapment or damage of these structures. As with the ulna, 3-4mm diameter pins are often more appropriate due to the size of the radius at the location the pins are being placed.

Figure 6. Pin placement in the forearm.

Upper extremity external fixator applied for open comminuted intra-articular distal humerus fracture with associated brachial artery injury from a high velocity gunshot wound. An expeditious spanning external fixator was used with smaller pins placed in the distal radial third of the radius followed by arterial shunting of the brachial artery, followed by debridement, and irrigation of the wounds. Note: The distal radial pin was adjusted after postoperative radiograph for over penetration.

Figure 6a: Distal Humerus Fx Brachial Artery

Figure 6b: X-ray of distal radial pin



HOST NATION CASUALTIES

One particular challenge for medical providers in an under-resourced host nation is the likelihood of treating individuals with unknown follow-up care. Low-energy, closed fractures may be treated definitively with a splint or cast. Plaster often is preferred to fiberglass for casting, as cast saws may not be locally available. Certain low-energy fractures may warrant open reduction and internal fixation or closed reduction and percutaneous pinning. External fixation is also an option for initial stabilization if transfer to a host nation facility is possible, or tempo of casualties allows for delayed internal stabilization. External fixation can be used successfully to definitively treat fractures but requires careful pin placement, long term construct stability and close follow up that may not be possible. In the setting of high-energy wounds with extensive soft tissue loss, a staged amputation that may be definitively closed in a short period of time must be considered. Unavailability of prolonged and advanced surgical care make limb salvage challenging.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Patients with long-bone fractures of the extremities (femur, tibia, humerus, radius, ulna).

INTENT (EXPECTED OUTCOMES)

1. All patients in the population of interest have a neurovascular exam documented at every role of care.

2. All patients in the population of interest have fractures stabilized (splinted or external fixator placement) prior to transport from the first surgical capability.

PERFORMANCE/ADHERENCE METRICS

- All long-bone extremity fractures are stabilized by splinting or external fixation prior to movement from a surgical capability.
- Neurovascular examination is documented for all extremity fractures.
- Casualties with fractures and vascular injury in the same extremity (i.e. vascular injury associated with fracture) who underwent vascular shunt or vascular repair also received external fixation.
- Number and percentage of patients in the population of interest who have a neurovascular exam documented at every role of care.
- Number and percentage of patients in the population of interest who have fractures stabilized (splinted or ex-fixed) prior to transport from first surgical capability.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed every five years; additional PI monitoring and system reporting maybe performed as needed.

The system review and data analysis will be performed by the JTS Chief and the PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: GUSTILO CLASSIFICATION OF OPEN FRACTURES

Gustilo Classification of Open Fractures

I	Low-energy clean wound <1 cm with minimal soft tissue injury and comminution
II	Wound >1 cm with moderate soft tissue damage and comminution. Soft tissue component often defined as disruption <10 cm without periosteal stripping. High-energy wound with skin wound <10 cm involving extensive software tissue destruction, segmental fracture with displacement or bone loss, high degree of contamination, and vascular injury.
IIIa	Fracture wound >10 cm with crushed tissue and contamination but usually with adequate soft tissue coverage or any size open wound associated with a segmental fracture (2 or more major fracture lines with intercalary fragment(s)).
IIIb	Fracture wound >10 cm with crushed tissue and contamination having inadequate soft tissue cover associated with periosteal stripping and often requiring transfer of rotational or vascularized tissue for soft tissue coverage.
IIIc	Open fracture associated with a major vascular injury that requires repair for limb salvage.

APPENDIX B: EX-FIX GUIDE FOR THE NON-ORTHOPAEDIC SURGEON

The purpose of an external fixator ("ex-fix") is to provide a temporizing measure to hold broken bones (usually the femur or tibia) in a reasonable position until further surgery can be performed. The ex-fix provides stability to bones that is particularly important in transfer situations in a combat zone, takes pressure off the surrounding soft tissue and joints, and provides pain relief to the patient.

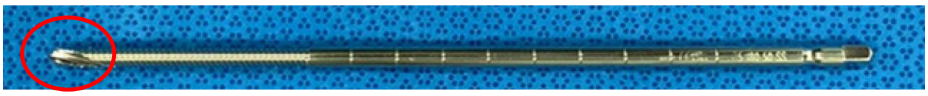
There are two main types of external fixator constructs:

1. Both sets of pins go in the same bone segment.
2. Joint-spanning external fixator: one set of pins goes in one bone, and the other set goes into the adjacent bone (e.g. knee-spanning external fixator consists of pins in the femur and the tibia). These are typically performed when the fracture occurs near a joint.

The basic construct consists of the following components:

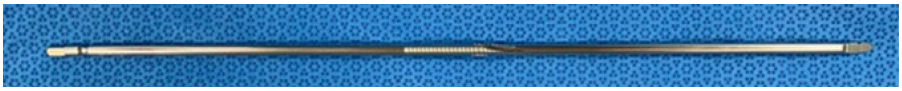
1. **Pins:** stainless steel pins that are drilled into bone, either on power or by hand. The tips of the pins are threaded to prevent them from backing out of bone.
   a. 5mm pins are typically used for the femur and tibia.
   b. The drill tip (circled) of the pin should be advanced through the bone to allow full engagement of the threads.

   Figure 1



   c. 4mm pins are typically used for the upper extremity and foot. A centrally-threaded (transfixation) pin may be placed through the calcaneus.

   Figure 2

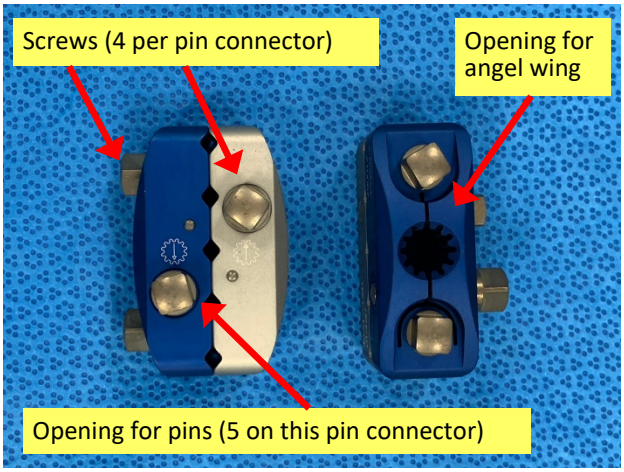


2. **Bars:** rods that connect to pins, or to other bars, via clamps. Modern bars are typically made of carbon fiber and are 11mm in diameter.

   Figure 3

3. **Pin connectors (AKA pin clamps):** blocks that allow two pins to be coupled together and provide an anchor point for attachment of angel wings. These contain screws that are tightened down to allow pins and angel wings to be locked into place.

Figure 4

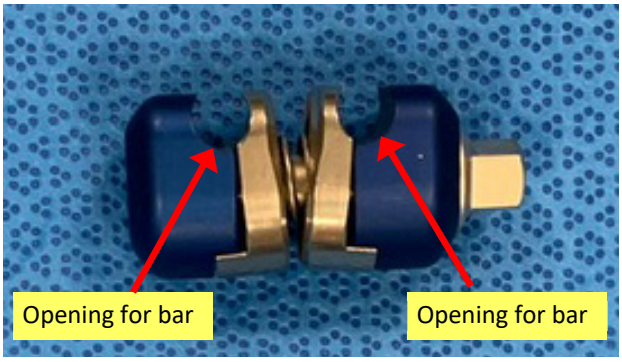


4. **Angel wings (AKA posts):** tiny bars that attach directly to pin connectors and allow for placement of bars via bar-to-bar clamps. These are optional but preferred by the authors for ease of use.

Figure 5

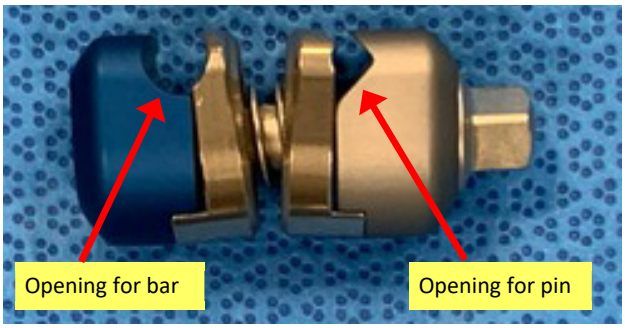
5. **Bar-to-bar clamps:** clamps consisting of two openings, one for each bar. These either attach the angel wings to a bar or, if more length is needed on the external fixator, attach two bars to each other.

Figure 6



6. **Pin-to-bar clamps:** clamps consisting of two openings, one for a bar and one for a pin. These are used in lieu of angel wings and allow the pin to be coupled directly to the bar.

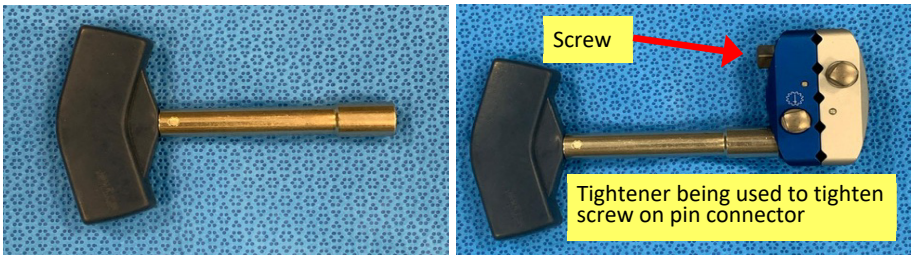
Figure 7



Instruments needed to place external fixator:

1. **Scalpel:** To make stab incision for each pin, no greater than 1cm.
2. **Drill:** Can be either hand drill or on power.
3. **Pin chuck:** May need to be tightened by hand with chuck key depending on system.
4. **Tightener:** Tightens screws on pin connectors and clamps to secure position of pins and bars.

Figure 8



Sterile Field Kit Components

Commercially available sterile field kits allow for placement of an external fixator by hand and typically consist of the following components:

1. **Scalpel**
2. **Mosquito clamp**
3. **Pins**
4. **Bars**
5. **Manual drill-brace**: Serves dual function as hand drill as well as tightener for clamps; each end is labeled for reference (“pin end” and “clamp).
6. **Bar-to-bar and/or Pin-to-bar clamps**
7. **Pin connectors:** Not available in every kit. May come pre-assembled with angel wing.

Basic principles:

1. Two pins (at least) are required on each end of the fractured bone.
2. Pins should avoid immediate proximity to the fracture site (at least 2-3 fingerbreadths away).

3. The external fixator is a tool to reduce fractured bone. Try to restore length and gross alignment.

Minimum Supplies: 4 threaded pins, 2 pin connectors, 2 bars, 2 angel wings (4 suggested), 4 bar-to-bar clamps. *Note: Fluoroscopy is beneficial but not essential.*

Step-By-Step Instructions

(Associated photos for a knee spanning external fixator)

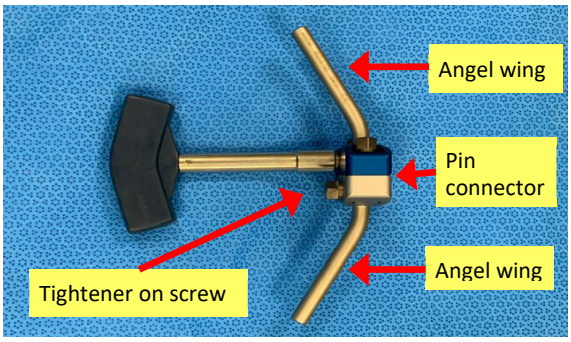
Pin Placement

1. Identify external fixator pin sites as described above, taking care to remain in safe zones.
   - **Femur:** Anterior or anterolateral
   - **Tibia**: Just medial to anterior tibial crest (ridge)
   - **Calcaneus (heel):** 1-2 fingerbreadths in front of (anterior) and above (proximal) to the posterior corner of the heel. Drill centrally-threaded pin from medial to lateral to avoid posterior tibial artery.
2. Start either proximal or distal to fracture.
3. Identify 1st pin site, use scalpel to make stab incision (7-10mm).
4. Use a blunt hemostat to dissect down to bone (keep tips of hemostat closed).
5. Insert pin perpendicular to bone (Figure 1).
   - **Pearl**: To drill the tibial pins, it can be helpful to start drilling perpendicular to the bone and create a divot without going all the way through the cortex, then redirect your hand so it is pointing toward the floor. This may help avoid slippage of the drill.
6. Place pin bicortically—when using a power drill to insert pins be wary of excessive depth of the pin that can damage deep structures. If inserting by hand and/or without power, once the far cortex is engaged (when increased resistance is felt as the pin is turned), advance the pin an additional 6-8 full turns to reach a safe depth. When fluoroscopic imaging is available, placing pins with power is safe and effective. Hand-inserted pins can be adjusted at follow on facilities when needed.
7. If the pin clamps are going to be used, slide pin connector over 1st pin to template location of 2nd pin and mark skin with pin or knife (Figure 2). If clamps are not available or desired, placing the pins in any safe location is possible followed by connection to bars with pin-bar or combination clamps.
8. Repeat steps 3-6 for 2nd pin. Placing the pin parallel to the first can reduce the complexity of the fixator, but off-plane pins can increase stability. Pin placement should be decided based on the associated anatomy, fracture and soft tissue injury patterns and fixator stability (Figure 3).
9. Move to proximal (or distal) pin site and repeat steps 1-8 (Figure 4).
10. Tighten down the screws securing the pins of the proximal and distal pin connectors, ensuring there are 2-3 finger-breaths between the pin connectors and the skin. This is important because swelling will often occur and may lead to skin compromise if the skin is too close to the pin connector. Putting the pin connector too far from the skin, however, will decrease the stability of the construct (Figure 5).
11. If fluoroscopy is available, confirm safe, bicortical position of all pins. The drill tip of the pin should be advanced to a depth allowing full engagement of the cortex with the threaded portion of the pin. A few of the threads of the pin should be penetrating through the second cortex.

External fixator Assembly

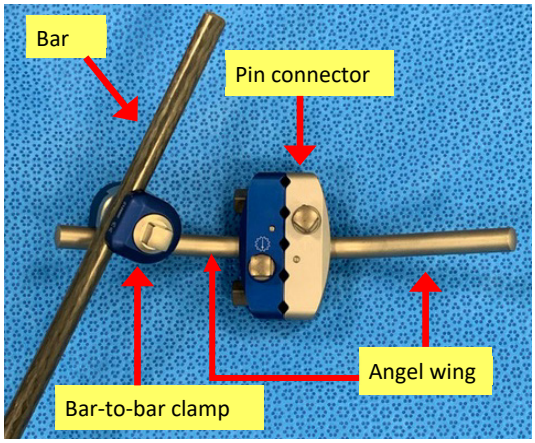
1. Place angel wings onto pin connectors and tighten all components into place with the hand tightener; this includes tightening all screws of the pin connector so that both the pins and the angel wings are secured. (Figure 5)

Figure 9



2. Loosely connect one bar on each angel wing both distally and proximally (If there is only one angel wing proximally and distally, two bars can be placed on the same angel wing to maximize stability).

Figure 10



Additional bar(s) may need to be placed on each side and connected to the other bars via bar-to-bar clamps for joint-spanning external fixatores in particular (Figures 6-9).

3. Apply longitudinal traction to restore length and correct the coronal and sagittal alignment of the limb ("make the leg look like a leg"). If fluoroscopy is available, the reduction can be optimized, but an anatomic reduction is not required. Bony apposition improves stability, but can be difficult to maintain with damage control fixators and quickly restoring overall alignment without delaying additional treatment or transfer in the acute phase is preferable.
4. Tighten all components (Figure 6 and Figure 7).
5. Confirm clinical alignment, as well as radiographic alignment if fluoroscopy is available.
6. Dress pins with petroleum gauze (if desired) and Kerlix wrapping between skin and pin connector. (Figure 8 and 9).

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Pain, Anxiety and Delirium (CPG ID: 29)

This CPG will delineate specific treatment guidelines for pain, anxiety and delirium (PAD) between Role 1, Role 2, Role 3 and higher echelons of care, with an emphasis on Role 3.

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***UPDATE**: The CPG was updated with battlefield acupuncture guidance (Apr 2021).*

SUMMARY OF CARE

1. Pain is universally present in combat casualties and an obligatory part of trauma care.
2. Adequate pain control is an essential part of care from point of injury to continental United States (CONUS) care; it has been shown to reduce the development of chronic pain syndromes and reduce the incidence of post-traumatic stress disorder.
3. Prior to escalating any treatment for pain, consider other potential physiologic etiologies.
4. Orders for the treatment of pain and anxiety should include set goals and the minimum amount of medication necessary to achieve the goals should be used.
5. The Acute Pain Service (APS) should be established and be an integral part of casualty care starting at the theater hospital (Role 3 care).
6. The primary mission of the APS is the provision of effective pain control as well as the treatment and prevention of anxiety and delirium in any injured patient. Standardized and validated scoring systems should be used (see appendices) for assessment and to guide therapies.
7. An APS should include a tracking system that lists all patients on the acute pain service, their injuries and therapeutic interventions along with treatment plan comments.
8. Refer to Table 1 in Appendix A for overall pharmacologic treatment guidelines for PAD.
9. See Appendix H for a sample order set including medication options and dosing.
10. Intermittent dosing of analgesics and anxiolytics should be instituted prior to continuous dosing and continuous drips should be stopped daily to obtain a reliable physical examination and to perform a spontaneous breathing trial in ventilated patients who are potential candidates for extubation.
11. In casualties with injuries that predispose them to compartment syndrome, the decision to use regional anesthesia must be carefully considered if the patients have not previously undergone fasciotomies. Regional anesthesia must be closely monitored in order to not mask a compartment syndrome.

GOALS

This CPG provides an evidenced based framework for the management of pain, agitation/anxiety and delirium (PAD) in injured combat casualties. It is a moral, medical, and operational imperative to provide state of the art pain services to combat casualties, in so forth reducing the incidence of chronic pain syndromes, PTSD, and long-term narcotic dependency. This process begins at the point of injury and Role 1 facility. As the casualty moves along the care continuum, pain and anxiety must continue to be addressed with the increasing capabilities inherent to the military Medical Treatment Facility (MTF). In this CPG, emphasis is placed on Role 3 care, as this is the first MTF that typically is equipped with robust treatment options. Optimal analgesia is a team effort and should be coordinated by the trauma surgeon, the Acute Pain Service (APS) consultant, and the critical care consultant in conjunction with the bedside nurse who ultimately delivers therapy and monitors the adequacy of it. This CPG will address the need for an APS at Role 3 care.[1-3] The APS will be introduced as a necessary adjunct to the Trauma Team. This multidisciplinary collaboration will assess analgesia needs throughout Role 3 care based on injury complexity, trauma burden, risks for coagulopathy / thromboembolic events, anticipated number of surgical procedures, evacuation plan, logistical constraints, and practitioner expertise. It is also important to recognize that pain control should be optimized as a priority over sedation and that the principle of "analgosedation" (i.e. analgesia based sedation) is a viable solution for critically injured casualties.[4]

This CPG will also delineate specific treatment guidelines between Role 1, Role 2, Role 3 and higher echelons of care. Role 1 care guidelines are incorporated from the Department of Defense Committee on Tactical Combat Casualty Care recommendations.

BACKGROUND

Pain is universally present in combat casualties. Ensuring that critically injured patients are treated for PAD is not only essential in the acute setting but also for preventing potential long-term consequences when they are not addressed appropriately. Beginning with point of injury (Tactical Combat Casualty Care) and continuing through the increasing echelons of care, active management of PAD, encompassing prevention, assessment, and treatment are medically and morally imperative. Given the magnitude of injury burden in our combat casualty population, surgical and life-sustaining treatment priorities may conflict, take precedent or overshadow the assessment and active management of PAD. Guidelines should be established understanding that sound clinical judgment, logistic and personnel constraints, and the operational context may dictate the use of other methods. Adequate early pain control to reduce posttraumatic stress disorder and ongoing pain control is an obligatory part of trauma care. The stress response involves a well-established sequence of physiologic and molecular events that include fever, tachycardia, tachypnea, hypertension, gastrointestinal ileus, hypercoagulability, protein catabolism, immunosuppression, among other undesirable consequences that delay or prevent a wounded warrior's full rehabilitation and recovery.[5,6] Effective pain management requires coordination of all medical providers from the point of injury throughout the echelons of care and the medical evacuation system.

Pain is frequently accompanied by anxiety and delirium in critically injured patients and the medications utilized to treat these conditions may paradoxically prolong or even exacerbate them. A multimodal approach to pain control can reduce the total dosage and duration of narcotics required, minimize or even eliminate complications associated with narcotics and reduce narcotic dependence.[7] Adjuncts such as acetaminophen, ketamine, non-steroidal anti-inflammatory drugs (NSAIDs), continuous peripheral nerve infusions, and continuous epidural infusions greatly increase patient safety and the effectiveness of narcotics while reducing the side effects.

TEAM-BASED MULTIMODAL APPROACH

1. The adoption of a team-based multimodal approach to the management of pain, anxiety and delirium most feasibly commences at the level of Role 3 care and should be continued throughout Role IV and subsequent CONUS care. This multimodal management includes the establishment of an acute pain service (APS) starting at the Role 3 and continuing for the duration of the casualty's care. The physician on the team who has the most, and preferentially extensive, experience in pain management should direct the APS. At the Role 3, the APS is staffed from existing Combat Support Hospital (CSH) assets and should include a physician (usually anesthesiologist) pain consultant, chief pain nurse, and ward pain nurse champions.[1,8,9]

2. The APS personnel should interact directly and frequently with the primary treating service, typically led by a trauma surgeon and/or intensivist. This is best accomplished by including the APS in daily rounds led by the primary trauma team and by incorporating the assessment and plan for pain management as a mandatory component of patient rounds. If is it not feasible to incorporate the APS into trauma rounds, then the APS is responsible for daily pain rounds, pain management consults, and reports to the trauma team leader

3. The APS should be available to all patients that are admitted to the Role 3 theater hospital. The primary mission of the APS is the provision of effective pain control as well as the treatment and prevention of

anxiety and delirium in any injured patient. There are standardized and validated scoring systems for the assessment of PAD; including the:

- DoD/VA Pain Rating Scale (Appendix B and Appendix C)
- Richmond Agitation Sedation Scale (RASS) (Appendix D)
- Confusion Assessment Method (CAM) (Appendix E)

4. The Defense and Veterans Pain Rating Scale (DVPRS) and supplemental questions have undergone, and continue to undergo, validation studies.[10] The DVPRS should be used to assess pain, the RASS score should be used to assess anxiety, and the CAM should be used to assess the presence of delirium. Consider potential surgical and medical causes of increased pain and anxiety prior to treating.

5. The APS should consist of an interdisciplinary team of physicians, nurses and pharmacists and should be available 24/7. In addition to participating in daily trauma rounds, they should be responsible for coordinating pain management plans with the validating flight surgeon, medical evacuation team and the receiving MTF. Additionally it should include a tracking and performance improvement (PI) system that follows all patients on the service listing their injuries, therapeutic interventions and care plan; this should be electronically maintained along the continuum of care.

6. To facilitate implementation and utilization of the APS a 'pain cart' with all of the needed supplies for regional anesthesia should be stocked in the anesthesia area. The regional anesthesia area should have immediate access to Advanced Cardiovascular Life Support (ACLS) medications and intralipid. An ultrasound machine should be available for the APS and anesthesia use to facilitate regional blocks. APS order sets can be utilized and should include pain management goals using the minimum amount of medication in order to achieve patient comfort. The goal for patients with delirium is to achieve a delirium free state as measured by the CAM.

   - See Appendix H for a sample order set including medication options and dosing.
   - See Table 1 in Appendix A for a summary list of recommendations.

PREVENTION

PAIN

Pain, as a product of trauma, cannot be prevented, per se, but there are many mechanisms for minimizing and managing pain. This begins with interrupting the mechanism and treating the injury, which are beyond the scope of this CPG; however, an essential part of long-term pain control is early and adequate intervention at the point of injury.[1,11-13] Pain recognition and assessment should be a routine part of combat casualty management followed by prompt intervention. Early interventions are essential to prevent the psychological and biochemical consequences of pain and pain related phenomenon, and to reduce the risk of chronic pain syndrome.[4] Orders for the treatment of pain and anxiety should include set goals and the minimum amount of medication necessary to achieve the goals should be used. These goals are determined by the need to achieve patient comfort and safety.

ANXIETY AND DELIRIUM

Similarly, the prevention of anxiety, agitation and delirium begin with recognition. All combat casualties are at risk for anxiety, which they may attempt to conceal or not disclose. As with pain prevention, management of the underlying etiology, including pain, hypoxia, metabolic abnormalities, and medications effects are essential principals. Disorientation to place and time as a result of unconsciousness, sedation, and loss of awareness

resulting from hospitalization contribute to PAD. This can be prevented with frequent and systemic efforts at reorientation and maintenance of normal sleep patterns.[4]

Interventions to promote healthy, REM sleep include exposure to bright light or sunlight during normal daytime hours and enforced darkness during normal night time hours. Orders should be written for scheduled periods of minimal or no disruption during normal sleep hours and allowing patients to use earplugs during sleep to minimize noise disruption. Conversely, patients should be provided with hearing aids or eye glasses, as needed, to combat sensory deprivation. Victims of close proximity blast exposure should be presumed to have some degree of hearing loss and undergo an audiology evaluation. Intermittent dosing of analgesics and anxiolytics should be instituted prior to continuous dosing. Patients who require dosing more frequently than every 2 hours should be placed on continuous dosing titrated to their goal.

Efforts to prevent delirium in critically injured patients include Awakening and Breathing Coordination (ABC), non-pharmacologic Delirium (D) interventions, and early Exercise (E) and mobility. The ABCDE's should be incorporated into treatment care plans for all ICU patients starting no later than the Role 3.[4,14] Propofol is an option for short term sedation in acutely agitated patients. It has rapid onset and it is also cleared rapidly. Propofol has been associated with hypotension which may be related to intravascular depletion. It is dissolved in a 10% lipid solution which should be accounted for when calculating calorie requirements. Propofol is an excellent drug for ICU patients scheduled to undergo Critical Care Air Transport Team (CCATT) missions. When used for transport, Propofol should only be administered to intubated patients.

Spontaneous Breathing Trials (SBT) should be performed daily. Physical and occupational therapy (PT/OT) should be initiated as soon as possible or at minimum 72 hours after intubation.[14,15]

There is insufficient evidence that prophylactic administration of antipsychotics to the general intensive care unit, (ICU) population prevents delirium and, therefore, we make no recommendation for it.[16] Benzodiazepines, although potentially useful for control of agitation, may increase delirium and should be avoided or minimized in patients experiencing or at increased risk for delirium.

EVALUATION OF PAIN

Some level of pain is present in all combat casualties. While the pain may be initially masked by the intensity of the situation, the combat medic or when the patient reaches the first level of care should assess the level of pain. Seriously injured patients who are not intubated should be assessed every 1-4 hours for the presence of pain. All patients who are intubated need to be continuously monitored for adequate analgesia. Signs of inadequate pain control in the intubated patient include tachycardia, hypertension and agitation. However – it is imperative that other causes be excluded such as early compartment syndrome, missed injuries, or impending physiologic decline. If the patient is appropriately communicative, then using the DoD/VA Pain Rating Scale (DVPRS) and Supplemental Questions as quantifiers can facilitate evaluation and trends.[3,10] All combat casualties will have a pain score recorded on admission to a Echelon III facility and as part of routine care while in the intensive care unit.

EVALUATION OF AGITATION AND DELIRIUM

The assessment of anxiety, agitation, delirium as well as pain can be complicated by the presence of traumatic brain injury (TBI). TBI, in addition to overall injury burden, and therapeutic interventions can affect the evaluation for agitation as well as impede an accurate neurologic assessment. Moderate to severe TBI patients are at particularly high risk for having atypical and/or paradoxical reactions to both sedating and stimulating agents.[17,18] In addition, the reactions to individual agents and their overall impact on the TBI patient in terms of pain, alertness, agitation, anxiety, and delirium may change drastically over relatively short periods of time as

their injury and cognitive status evolves. The following tools help with pain evaluation: Richmond Agitation Sedation Scale (RASS), and the Confusion Assessment Method (CAM); they are included as Appendices D and E.

TREATMENT OF PAIN: GENERAL INFORMATION

As previously stated pain is a universal symptom of the combat injured patient and must be managed early and effectively. Adequate early pain control has been shown to reduce post-traumatic stress disorder and ongoing pain control is an obligatory part of trauma care. Inadequate treatment results in undesirable consequences that delay or prevent a wounded warrior's full rehabilitation and recovery.

Non-pharmacologic pain therapies should be considered first-line treatment for mild to moderate pain or an adjunct to opioid medications. This includes Battlefield Acupuncture (BFA) when administered by an appropriately qualified clinician and supplies are available. (See Appendix F.)

With regards to specific opioid medications, any opioid available can be titrated to equal effectiveness for achieving desired pain control. This CPG is going to emphasize the use of Ketamine throughout the deployed continuum of care. Ketamine is a very effective analgesic either by itself or as an adjunct to opioid analgesia and can be used to reduce the total narcotic burden.[19,20] Ketamine, in parenteral doses of 0.15-0.3 mg/kg, has been shown to reduce pain scores, total narcotic use, and need for rescue medication when used with morphine for acute pain control.[20]

ROLE 1 TREATMENT OF PAIN

The Role I pain treatment guidelines described here are adopted directly from the most recent protocols developed by the Department of Defense's Committee on Tactical Combat Casualty Care (TCCC), available online at Deployed Medicine. The most current guidelines, with full course material and supporting documentation, is available through a Common Access Card enabled webpage from the Military Health System (https://mhs.health.mil/References/REF_TCCC.cshtml).

Additionally, the *Journal of the Special Operations Medical Association* maintains free access to the current protocols (https://www.jsomonline.org/TCCC.html).[21,22] See Appendix H for a sample order set including medication options and dosing.

Analgesia on the battlefield should generally be achieved using one of three options, per the TCCC triple analgesia protocol. This is an abbreviated presentation of that protocol. The detailed description can be obtained via websites described above.

- **Option 1**, for mild to moderate pain when the casualty is still able to fight should include the TCCC Combat pill pack with acetaminophen and meloxicam given simultaneously.
- **Option 2**, for mild to moderate pain when the casualty is not in shock or respiratory distress, and the casualty is not at significant risk of developing either condition, should include oral transmucosal fentanyl citrate (OTFC) 800 ug. Naloxone (0.4 mg IV or IM) should be available when using opioid analgesics.
- **Option 3**, for moderate to severe pain when the casualty is in hemorrhagic shock or respiratory distress or the casualty is at significant risk of developing either condition, should include ketamine 50 mg IM or IN or ketamine 20 mg slow IV or IO. Ketamine doses can be repeated every 30 minutes for IM or IN and every 20 minutes for IV or IO administration.

Casualties should be disarmed after being given Oral Transmucosal Fentanyl Citrate (OTFC) and always disarmed after receiving ketamine. Documentation of a mental status exam using the alert, verbal, pain, and unresponsive

(AVPU) method should be performed prior to and after administering opioids or ketamine, and recorded on the TCCC Card (DD Form 1380, JUN 2014). Ketamine may be a useful adjunct to reduce the amount of opioids required to provide effective pain relief. It is safe to give ketamine to a casualty who has previously received morphine or OTFC. IV Ketamine should be given over 1 minute.

ROLE 2 TREATMENT OF PAIN

Damage Control Surgery is provided at Role 2. An anesthesiologist and/or certified registered nurse anesthetist will be on staff and in conjunction with the surgeons, will be responsible for perioperative pain management. Role 2's differ in their capability with some consisting of a single operating room bed and a single post-operative ICU bed while others have attached Emergency Care and Post-Operative Holding Capacity.

In the more austere Role 2, pain should be managed with intravenous opioids and ketamine titrated as needed to provide adequate pain control; if dysphoric symptoms emerge with ketamine, then a small amount of benzodiazepine should be administered.

More robust Role 2's will have additional personnel, equipment, and supplies available. At these locations, the capability might exist for peripheral nerve blocks, which could be performed by the anesthesia provider or by the orthopedic surgeon assigned to the unit. Infusion pumps may also be available for continuous opioid infusions in critically injured patients, with dosage titrated as needed to provide adequate pain control. Patients on infusions require close monitoring in an ICU setting. Some of these more robust Role 2's with attached ward holding may have Patient Controlled Analgesia (PCA) pumps that can be used by patients to manage their pain. Pain should be adequately controlled prior to starting PCA; the patient can then use the PCA for self-dosing as needed for pain. The starting doses for PCAs are as follows:

1. Morphine PCA in adults is 1-3 mg with 10-20 minute lockout
2. Hydromophone PCA in adults is 0.1-0.3 mg with 10-20 minute lockout
3. Fentanyl PCA is 15-25 mcg with 10-20 minute lockout.

Patients on PCA require monitoring by nursing staff. Naloxone must be available to treat respiratory distress that may occur secondary to opioids.

ROLE 3 TREATMENT OF PAIN

Regional anesthesia procedures should be performed in a monitored setting where nursing staff is available to help with patient care and provide appropriate recovery services for the patients. The Acute Pain Service (discussed extensively above) should maintain and provide input for standing orders to include:

- Continuous epidural and peripheral nerve catheter infusion and single injection epidural or intrathecal narcotics.
- Intravenous patient controlled analgesia (PCA) Orders. Fentanyl, hydromorphone, and morphine are the narcotic agents of choice. (Meperidine (Demerol) is not an approved compound for repeated PCA dosing as the metabolite normeperidine reduces the seizure threshold.)

Low dose ketamine infusions have profound analgesic effects with very minimal side effects. The anti-inflammatory effects of ketamine may also attenuate the systemic inflammatory response seen in trauma.[13,23,24] Ketamine binds the NMDA receptor and in addition to having direct analgesic properties, it also decreases the total dose of narcotics that is needed for adjuvant pain control.

Ketamine infusions should be made as follows:

- 250 mg of Ketamine in 250 ml of normal saline.
- For patients who are 70 kg or greater and less than 60 years old, start infusions at 10 mg per hour in the setting of acute and neuropathic pain.
- Patients > 60 year old or <70kg should receive 100 micrograms/kg/hour of ketamine in the setting of acute or neuropathic pain.
- Custom orders may be titrated by the attending anesthesiologist or critical care physician.

EPIDURAL CATHETERS

Neuraxial analgesia can be a very effective pain treatment in the injured warfighter, but special care must be taken to ensure that it is provided safely. Standard preservative free local anesthetics include ropivacaine and bupivicaine. The standard medication for aeromedical evacuation is 0.2% ropivacaine with sufficient volume for 3 days. Patients should be on stable doses of infusions prior to AE transportation. The risk/benefit of epidural placement must be considered in the injured combat casualty who is also at risk for venous thromboembolic events. While all antiplatelet and anticoagulant medications increase the risk of bleeding, low molecular weight heparin (LMWH) use in patients undergoing epidural anesthesia greatly increases the risk of epidural hematoma, which can lead to paralysis. The acute pain service should maintain and provide input for standing orders to include:

1. All catheters should receive a 3 ml test dose of local anesthetic containing at least 1:400,000 epinephrine.
2. Low molecular weight heparin (LMWH) use in patients undergoing epidural anesthesia increases the risk of spinal or epidural hematoma, which may cause long term or permanent paralysis. We recommend against the use of LMWH in AE patients given the increased motion of delivery catheters during patient transport and resulting increased risk for spinal & epidural hematoma formation.
3. Prophylactic LMWH dosing should be held for 12 hours prior to placement of an epidural catheter.
4. Therapeutic dosing should be held for 24 hours prior to placement of epidural catheters.
5. Administration of LMWH should be delayed for 2 hours after catheter removal.
6. The maximum recommended prophylactic dose of LMWH with an epidural catheter in place is 40 mg SQ daily.
7. Twice daily dosing of LMWH is not recommended for patients with indwelling epidural catheters.
8. The initial dose of once daily prophylactic LMWH should not be given until 6-8 hours after catheter placement. Subsequent daily doses should start 24 hours after this first dose.

These recommendations are consistent with the most recent ASRA (American Society of Regional Anesthesia) guidelines for the prevention of epidural hematoma.

***Note**: Given that our patients are transported through a spectrum of care and across thousands of miles, the implementation of regional anesthesia should be integrated throughout the trauma system and must be safe and effective. An anesthesia provider is responsible for the initial placement and dosing of an epidural catheter. Only members of the Acute Pain Service can change the dosing or infusion rate*.

Appendix G is a summary of the American Society of Regional Anesthesia guidelines as they relate to use of LMWH in combat casualties. The ASRA guidelines were originally developed for use of LMWH in the perioperative course.

Additionally, these recommendations change on a frequent basis; https://www.asra.com/ should be consulted for the most current recommendations.

PERIPHERAL NERVE CATHETERS

1. All catheters should undergo a local anesthetic test dose containing 1:400,000 epinephrine.
2. For patients undergoing deep plexus or peripheral block, we recommend that recommendations regarding neuraxial techniques be similarly applied.
3. Each patient should have no more than two catheters and the total dose of 0.2% Ropivacaine should not exceed 20 ml per hour.
4. Regional anesthesia patients should be recovered by standard post anesthesia care unit (PACU) criteria.

Patients with epidurals and peripheral nerve blocks should be held in recovery until they meet standard discharge criteria from PACU and ICU. Patients with peripheral nerve blocks and epidural catheters that have met discharge criteria from ICU and PACU may be managed on the floor. Any patient with an epidural catheter or peripheral nerve block must be closely monitored for signs or symptoms of compartment syndrome (see below). No narcotics will be added to the peripheral nerve block or epidural infusions given the ongoing revision of validation for air transport by the United States Air Force (USAF).

TREATMENT OF ANXIETY AND AGITATION

Given the nature of combat injuries and the environment of care, both agitation and anxiety can be expected and should be preemptively managed. In a patient with normal hemodynamics, propofol is a good option for short-term sedation. **Propofol** does not provide analgesia; it is the most commonly used medication when sedation is required for ICU patients and CCAT transports due to its rapid onset and clearance. It is a $GABA_A$ agonist with rapid onset and clearance. Propofol can cause hypotension and should be used with caution in patients with intravascular depletion. Propofol is dissolved in a 10% lipid solution. It is an excellent drug for ICU patients scheduled to undergo aeromedical evacuation. Propofol should only be administered to patients who have a definitive airway (endotracheal tube, tracheostomy), are hemodynamically stable and are continuously monitored by trained personnel.[4,25,26]

Dexmedetomidine is being used with increasing frequency in ICU patients and occasionally for transport. It minimally decreases respiration, so it can be used for patients on non-invasive mechanical ventilation or sedation for an awake intubation. It has some mild analgesic effects. It should be used with caution in patients with bradycardia or heart block. Dexmedetomidine is a relatively selective alpha-2 agonist; it is a good option for short-term sedation and anxiolysis. Dexmedetomidine has minimal impact on respiratory drive allows for ongoing assessment of the patient's mental status.[4]

Clonidine is an effective drug for treating patients with anxiety and agitation; it is particularly effective for patients with hypertension associated with agitation.[5,27] Clonidine acts as an alpha-2 adrenergic agonist and also has sedative properties that do not result in respiratory suppression. It may also be used for mild sedation and analgesia.[27]

TREATMENT OF DELIRIUM

The typical antipsychotic **haloperidol (Haldol®)** and the atypical antipsychotic **quetiapine (Seroquel®)** are commonly used for the treatment of delirium. Quetiapine can also be used as an anxiolytic; it is particularly effective when used QHS PRN to help regulate sleep in a patient at risk for anxiety and delirium. Both of these drugs may be associated with prolongation of the QT interval potentially resulting in fatal arrhythmias secondary to torsades des pointes. If these drugs are used, the QTc interval should be monitored with an electrocardiogram (EKG) on a daily basis. They should be discontinued if the QTc exceeds 500 msec or the interval increases 60 msec from baseline.[4]

PREVENTING COMPLICATIONS

Medications should be specifically directed and dosed to achieve a defined goal, for example:

- Achieve a pain score of 4 or less
- Maintain sufficient patient consciousness to assess the evolution of injuries by physical exam
- Decrease the need for mechanical ventilation
- Amelioration of symptoms of anxiety, delirium or agitation

BENEFITS OF SEDATION HOLIDAY AND INTERMITTENT MEDICATION DOSING

INTERMITTENT DOSING

Intermittent dosing of analgesics and anxiolytics, as opposed to continuous dosing, has been shown to reduce the duration of mechanical ventilation and intermittent dosing of analgesics and anxiolytics should be instituted prior to continuous dosing. Although many sedative agents are utilized for their short duration of action (e.g. midazolam), administration as a continuous infusion will often result in a prolonged duration of action and effect due to fat storage an accumulation of active metabolites. It is recommended that intermitted sedation be used whenever feasible. For patients who require dosing more frequently than every 1-2 hours, continuous dosing titrated to effect can be used; however, continuous infusions should be converted to intermittent dosing as early as possible.

SEDATION VACATIONS

Daily interruptions of sedation ("sedation vacations") have repeatedly demonstrated reduction in the duration of mechanical ventilation as well as the incidence of ventilator-associated pneumonia.[21] Intermittent dosing and daily sedation holidays prevent the accumulation of active metabolites, which may impede patient assessment for prolonged periods of time.[25,28]

- Continuous infusions should be stopped daily to obtain a reliable physical examination, including neurologic assessment, and to perform a spontaneous breathing trial in ventilated patients.
- Sedation Goals should be assessed every day following sedation holidays and every effort should be made to reduce infusion doses.

CONTRAINDICATIONS TO THE DAILY SEDATION HOLIDAY:

- Intractable intracranial hypertension.
- Hemodynamic instability.
- Inability to adequately oxygenate or ventilate mechanically ventilated patients.

See Appendix H for a **sample order set** including medication options and dosing.

See Table 1 in Appendix A for **suggested management algorithms.**

LOCAL ANESTHETIC TOXICITY

Local anesthetic toxicity is extremely rare in a patient who has an established neuraxial or peripheral nerve catheter. If suspected, all local anesthetic infusions should be immediately stopped. Occasionally the presenting symptom is cardiac arrest. In cardiac arrest, the patient should immediately receive 1.5 ml/kg of 20% Intralipid while receiving chest compressions and other ACLS interventions such as airway management. Repeat the bolus 1-2 times as needed for persistent asystole, pulseless electrical activity or reemergence of hemodynamic insanity. Increase the infusion rate to 0.5 mL/kg/min if hemodynamic instability persists or recurs. Continue the infusion for at least 10 min after hemodynamic stability is restored; discontinue within 1 hour if possible. Another rare symptom of local anesthetic toxicity is seizure. Once again, the infusion should be stopped, seizure should be treated with an anti-seizure medication and the airway should be controlled if necessary. Much more common symptoms of local anesthetic toxicity are tinnitus, anxiety, restlessness, dizziness and blurred vision; in the case of these symptoms, the infusion should be stopped.

1000 ml of 20% Intralipid should accompany patients receiving local anesthetic infusions during transport in the AE System.

NAUSEA

Nausea is a common side effect of both trauma and the medications used to treat pain, anxiety, and delirium. Consider prophylactic treatment whenever possible and treat immediately upon patient report of symptoms. If the patient has recently undergone an emergency general anesthetic or any type of abdominal surgery, then ensuring that they are not at aspiration risk is important prior to medication. If there is a concern for gastric distention or any type of obstruction (functional or mechanical), then the patient should receive gastric decompression with an NG tube in additional to pharmacologic management for nausea.

Ondansetron is a safe antiemetic in the adult population and is increasingly the therapy of choice for acute undifferentiated and trauma-related nausea.[29] It has no effect on consciousness or the respiratory drive; additionally, at the doses recommended for these patients (4-8 mg per dose) has no clinically significant effect on QT interval.[29,30]

COMPARTMENT SYNDROME

Compartment syndrome is a well-described complication of traumatic injury; for the purposes of this CPG, only extremity compartment syndrome will be discussed. Definitive treatment is complete surgical release of the extremity compartments affected. The acute pain anesthesiologist and trauma surgeon should have a detailed discussion regarding patients who are at high risk for compartment syndrome. Pain control may mask the typical early sign of compartment syndrome: increased pain in the compartment. Any patient at risk for extremity compartment syndrome who is awake and has an increased pain medication requirement should be promptly and thoroughly assessed for increased compartment pressure. For patients with regional or neuraxial analgesia affecting an extremity that is felt to be at risk for compartment syndrome, more frequent clinical assessments and monitoring of the extremity are warranted. If the patient is unable to reliably detect and report pain and there are any clinical or examination findings concerning for a compartment syndrome, then bedside assessment of compartment pressures or performance of a fasciotomy should be done promptly. If there is any concern for compartment syndrome, then full compartment release with fasciotomies must be completed prior to aeromedical transportation. Newer monitoring technologies such as near infrared spectroscopy; have shown

some promise in early noninvasive detection of compartment syndrome; however, they are not currently the standard of care.

AIR EVACUATION CONSIDERATIONS

The United States Air Force (USAF) Patient Movement Request (PMR) must state the type of regional anesthesia being utilized. All individuals participating in the care of the patient should have up-to-date training and experience with regional anesthesia, techniques, medications, and equipment. All equipment associated with the use of regional anesthesia must be approved for flight. The current infusion pump system that has been approved by the USAF for air evacuation is the small portable Ambit pump. Ambit pumps should be used for epidural, peripheral nerve catheters, ketamine infusions, narcotic infusions, and patient controlled anesthesia. For all patients receiving regional anesthesia/analgesia, coordinate with the Trauma Chief, Theater Validating Flight Surgeon and Theater CCATT Director prior to any planned fixed-wing tactical (Intratheater) or strategic (Intertheater) transport to ensure patient safety during flight operations.

Patients undergoing prolonged air evacuation are exposed to a multitude of austere environments over a relatively short period of time. CCATT providers recognize that turbulence, weather, temperature, limited patient access and monitoring constraints make it inherently difficult to maintain sedation and analgesia. It may be necessary to empirically increase sedation and pain regimens to maintain a safety margin that protects endotracheal tubes and other invasive devices. This clouds a patient's neurologic exam. Therefore patients with potential intracranial injury (TBI or stroke) who cannot be serially, neurologically evaluated should have intracranial pressure monitors.

In terms of peripheral nerve blocks or epidural catheters, no narcotics will be added to the infusions; the addition of narcotics to these regional therapies changes the validation for air transport by the USAF.

GUIDANCE

- The Military Advanced Regional Anesthesia and Analgesia handbook is an excellent APS reference text for pain care standards (https://medcoe.army.mil/borden-4-specialty-titles).
- Tri-service policies for pain management can be found at https://www.dvcipm.org/.
- Strategic issues on evacuation pain management should be referred by the health care facility American Physical Society (APS) physician to the Defense and Veterans Pain Management Initiative organization (https://www.dvcipm.org/).

PERFORMANCE IMPROVEMENT (PI) MONITORING:

POPULATION OF INTEREST

All injured patients

INTENT (EXPECTED OUTCOMES)

1. Patients in the population of interest have a documented pain assessment at every role of care.
2. Patients in the population of interest in the intensive care unit are screened for delirium daily.
3. Intubated patients will not experience an inadvertent or unplanned extubation.

PERFORMANCE ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have a documented pain assessment at each role of care.
2. Number and percentage of patients in the population of interest in the intensive care unit with documented delirium screen daily.
3. Number and percentage of intubated patients who experience an inadvertent or unplanned extubation.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

All healthcare providers will:

1. Become familiar with the guidelines for the management of pain, anxiety and delirium in critically injured patients.
2. Appropriately manage patients with pain, anxiety and delirium.
3. Provide feedback on these guidelines and suggestions for changes to the CPG to the JTS Director.

The Trauma Chief, Pain Director and Intensivist at each level III facility will:

1. Implement care that is consistent with the intent of this CPG.
2. Monitor adherence with the CPG.

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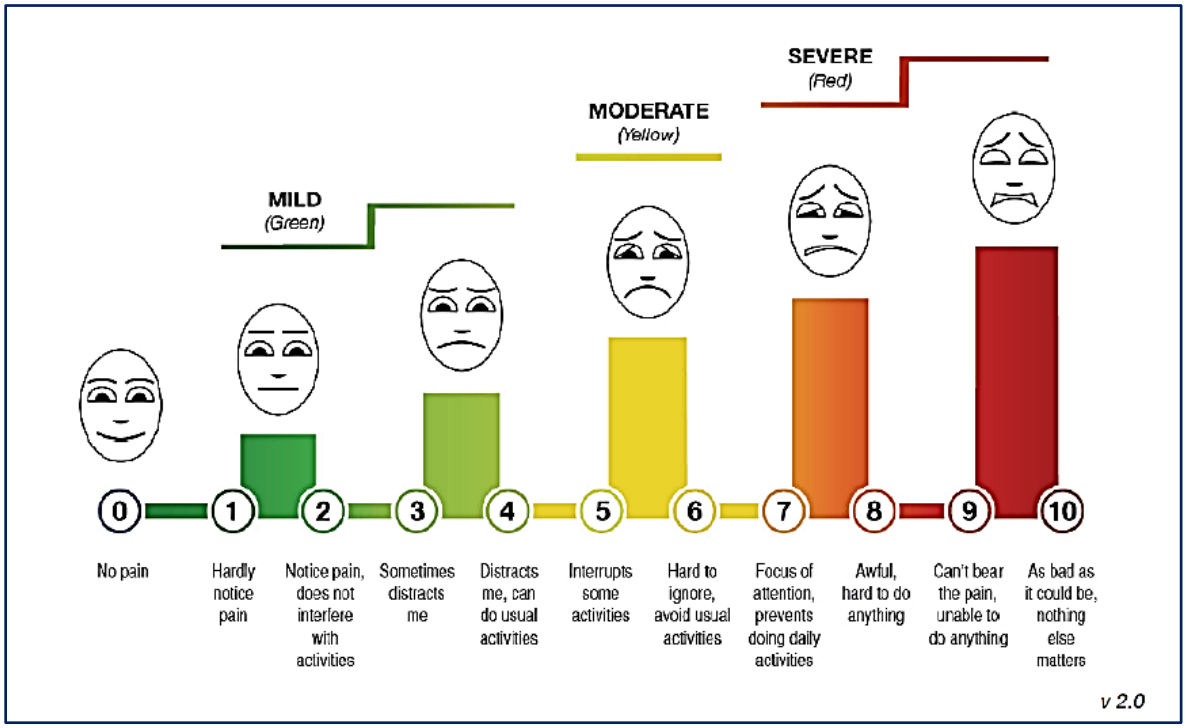
APPENDIX A: PAIN, ANXIETY (SEDATION) AND DELIRIUM GUIDELINES

		Intubated Hemodynamically Unstable or severe ARDS	Intubated Hemodynamically Stable, adequate gas exchange	Not Intubated Stable
		Goals: Minimize pain, patient safety RASS -3 to -4, no sedation holiday, consider paralysis	**Goals: Minimize pain, patient safety RASS -1 to -2, daily sedation holiday or continuously interactive patient**	**Goals: Minimize pain, patient safety RASS 0, continuously interactive patient**
Background	Pain	*Option 1:* Ketamine drip *Option 2:* Intermittent Narcotic (*Option 1 for TBI) *Option 3:* Fentanyl or drip or equivalent if tolerated	*Option 1:* fentanyl drip or equivalent *Option 2:* Ketamine Drip *Option 3:* Intermittent Narcotic (*Option 1 for TBI)	*Option 1*: Scheduled Enteral or Parenteral Narcotic *Option 2:* Intermittent as needed enteral or parenteral narcotic
	Sedation	*Option 1:* Ketamine drip *Option 2:* Intermittent Benzodiazepine *Option 3:* Propofol drip if tolerated (*Option 1 for TBI)	*Option 1:* Propofol Drip *Option 2:* Demedetomidine Drip *Option 3:* Intermittent Benzodiazepines	NA
	Adjuncts	*Consider first:* Axial or regional anesthetic by catheter or injection *Consider also:* – scheduled acetaminophen or paracetamol – gabapentin and/or TCA for amputees		
Breakthrough	Pain	*Option 1:* Intermittent/bolus ketamine *Option 2:* Intermittent/bolus narcotic	*Option 1:* Intermittent/bolus narcotic *Option 2:* Intermittent/bolus ketamine	*Option 1:* PCA *Option 2:* Intermittent as needed enteral or parenteral narcotic
	Sedation	*Option 1:* Intermittent/bolus ketamine *Option 2:* Intermittent/bolus benzodiazepine	*Option 1:* Intermittent/bolus benzodiazepine *Option 2:* Intermittent/bolus ketamine	*Option 1*: As needed enteral or parenteral benzodiazepine
	Adjuncts	*Consider:* – Dim, calm environment, reassurance, music, presence of friends/family – Give bolus and/or adjust dose of axial or regional anesthetic		
Procedural	Pain	*Option 1:* Intermittent/bolus ketamine *Option 2:* Intermittent/bolus narcotic	*Option 1:* Intermittent/bolus ketamine *Option 2:* Intermittent/bolus narcotic	*Option 1:* Planned pre-procedural enteral or parenteral narcotic *Option 2:* Pre-procedural ketamine *Option 3:* Demedetomidine
	Sedation	*Option 1:* Intermittent/bolus ketamine *Option 2:* Intermittent/bolus benzodiazepine	*Option 1:* Increase dose of background propofol +/- propofol bolus *Option 2:* Intermittent/bolus benzodiazepine *Option 3:* Intermittent/bolus ketamine	*Option 1:* Pre-procedural ketamine +/- benzodiazepine *Option 2:* Planned pre-procedural enteral or parenteral benzodiazepine *Option 3:* Demedetomidine
Delirium	Prevention & Management	– Maintain day night cycles – Consider afternoon naps – Consider ear plugs at night – Consider less sedation and avoid benzodiazepines – Prioritize early mobility and patient interaction		
	Treatment		Consider dexmedetomidine for sedation and/or at night for sleep Consider quetiapine	

APPENDIX B: DOD AND VA PAIN RATING SCALE



APPENDIX C : DOD AND VETERANS PAIN SUPPLEMENTAL QUESTIONS

1. Circle the one number that describes how, during the past 24 hours, pain has interfered with your usual ACTIVITY:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

Does not interfere — Completely interferes

2. Circle the one number that describes how, during the past 24 hours, pain has interfered with your SLEEP:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

Does not interfere — Completely interferes

3. Circle the one number that describes how, during the past 24 hours, pain has affected your MOOD:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

Does not affect — Completely affects

4. Circle the one number that describes how, during the past 24 hours, pain has contributed to your STRESS:

0 — 1 — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 — 10

Does not contribute — Contributes a great deal

**Reference for pain interference: Cleeland CS, Ryan KM. Pain assessment: global use of the Brief Pain Inventory. Ann Acad Med Singapore 23(2): 129-138, 1994.*

v 2.0

APPENDIX D: RICHMOND AGITATION SEDATION SCALE (RASS)

Score	Term	Description	
+4	Combative	Overtly combative, violent, immediate danger to staff.	
+3	Very Agitated	Pulls or removes tube(s) or catheter(s); aggressive.	
+2	Agitated	Frequent non-purposeful movement, fights ventilator.	
+1	Restless	Anxious but movements not aggressive vigorous.	
0	Alert, Calm		
-1	Drowsy	Not fully alert, but has sustained awakening (eye-opening/eye contact) to voice (≥10 seconds).	Verbal Stimulation
-2	Light Sedation	Briefly awakens with eye contact to voice (<10 seconds).	
-3	Moderate Sedation	Movement or eye opening to voice (but no eye contact).	
-4	Deep Sedation	No response to voice, but movement or eye opening to physical stimulation.	Physical Stimulation
-5	Unarousable	No response to voice or physical stimulation.	

Procedure for RASS Assessment	
1. Observe patient: Patient is alert, restless, or agitated.	Score 0 to+4
2. If not alert, state patient's name and say to open eyes and look at speaker	
- Patient awakens with sustained eye opening and eye contact.	Score -1
- Patient awakens with eye opening and eye contact, but not sustained.	Score -2
- Patient has any movement in response to voice but no eye contact.	Score -3
3. When no response to verbal stimulation, physically stimulate patient by shaking shoulder and/or rubbing sternum.	
- Patient has any movement to physical stimulation.	Score -4
- Patient has no response to any stimulation.	Score -5

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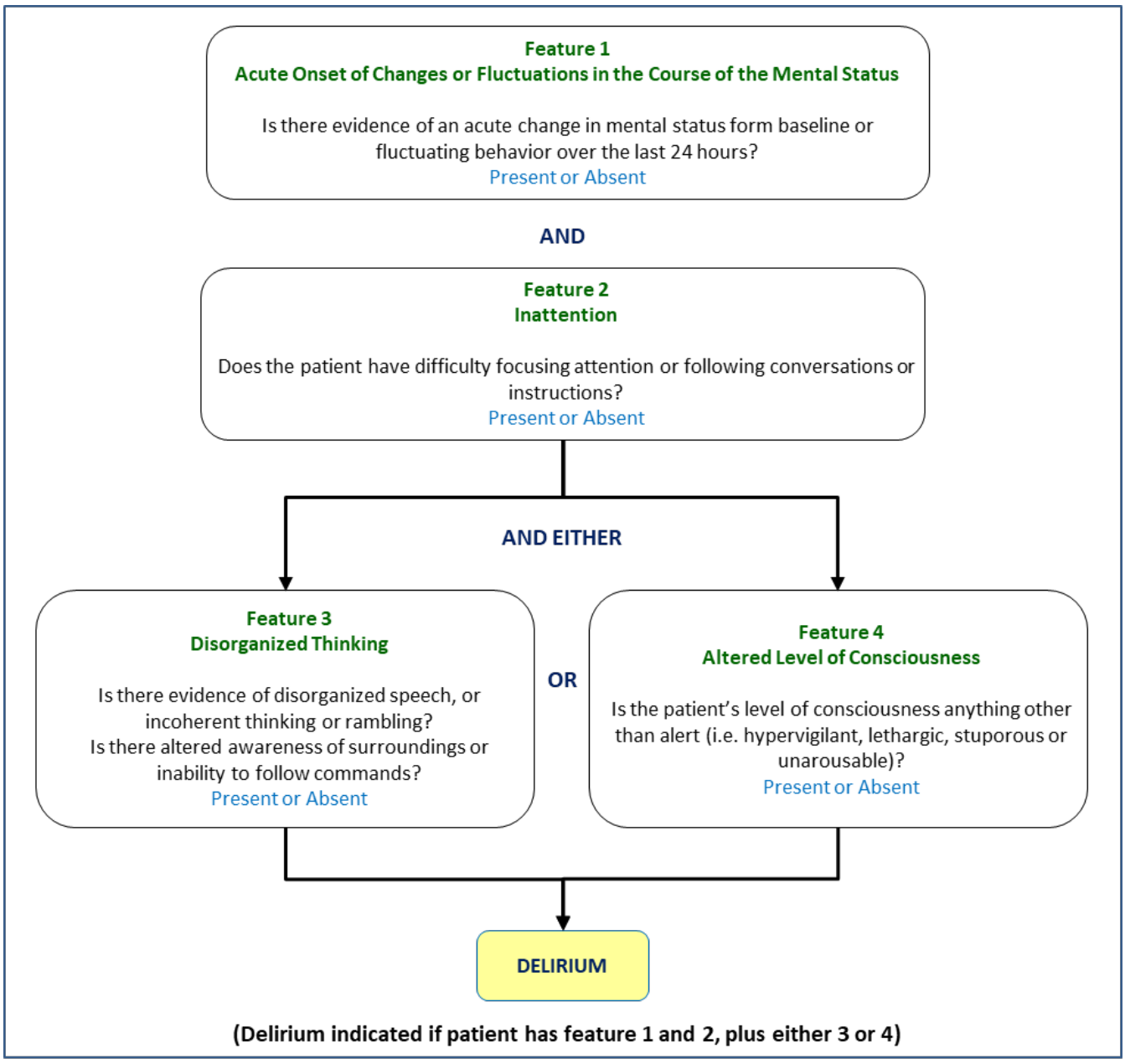
APPENDIX E: THE CONFUSION ASSESSMENT METHOD


Feature 1
Acute Onset of Changes or Fluctuations in the Course of the Mental Status
Is there evidence of an acute change in mental status form baseline or fluctuating behavior over the last 24 hours?
Present or Absent
AND
Feature 2
Inattention
Does the patient have difficulty focusing attention or following conversations or instructions?
Present or Absent
AND EITHER
Feature 3
Disorganized Thinking
Is there evidence of disorganized speech, or incoherent thinking or rambling?
Is there altered awareness of surroundings or inability to follow commands?
Present or Absent
OR
Feature 4
Altered Level of Consciousness
Is the patient's level of consciousness anything other than alert (i.e. hypervigilant, lethargic, stuporous or unarousable)?
Present or Absent
DELIRIUM
(Delirium indicated if patient has feature 1 and 2, plus either 3 or 4)

APPENDIX F: BATTLEFIELD ACUPUNCTURE (BFA)

BFA requires appropriate training through the Acupuncture and Integrative Medicine Center at Joint Base Andrews or other approved training organization. An exception would be physicians without formal training but the requisite skills that easily translate to this procedure (i.e. surgeons, anesthesia, ER, critical care).

Supplies Needed: 10 Auricular Semi-Permanent (ASP) needles and alcohol pads.

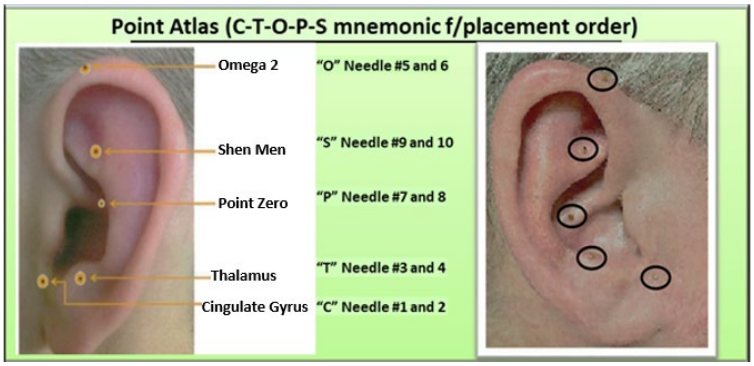
Patients should NOT receive BFA if:

- The patient has an active infection in an ear that is going to be used for BFA (treat only uninfected ear)
- A bleeding disorder is present (relative contraindication)
- The patient is pregnant or might be pregnant
- Current or previous keloid scar formation on either ear

Steps to apply BFA needles:

Read ALL steps before proceeding.

1. **Patient Education and Consent –** explain the procedure and expected course of having the ASP needle in place for 2-4 days while continuing regular activities.
2. **Cleanse area** – use alcohol swabs to disinfect both ears.
3. **Place ASP needles**
   a. Begin by applying needle at lowest point shown in figure below (the Cingulate Gyrus). Start on the side with most pain, then switch to the opposite side after body movements described in step b. Proceed to the next point and continue alternating sides until pain is resolved (0 or 1 out of 10).
   b. After each needle application, the patient should walk 10-20 steps unassisted or move their arms/legs for 30-60 seconds if physically unable to walk unassisted.
   c. If adverse symptoms are noted during the procedure, the last needle placed should be removed unless doing so is too uncomfortable. Symptoms include lightheadedness, near-fainting, euphoria, or increasing pain level.



4. **Post-care**
   a. Recommend patients keep brief written notes of their response to treatment.
   b. There is a small possibility of drowsiness, lightheadedness, and/or euphoria occurring up to 30 minutes after treatment.
   c. If effective, additional BFA treatments may be repeated every (5-7 days).

For more information, refer to the BFA Handbook on Deployed Medicine.

- *Fox LM, Murakami M, Danesh H, Manini A.Battlefield acupuncture to treat low back pain in the emergency department. Am J Emerg Med. 2018 Jun;36(6):1045-1048.*
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APPENDIX G: REGIONAL ANESTHETIC USE

Consensus Statement of American Society of Regional Anesthesia (ASRA) on LMWH as it relates to regional anesthetic use, adapted for use in combat casualties.

1. Antiplatelet or oral anticoagulant medications administered in combination with LMWH increases the risk of spinal hematoma. ASRA recommends against concomitant administration of antiplatelet drugs, standard heparin, dextran or coumadin, regardless of LMWH dosing regimen.
2. Needle placement should be delayed at least 10 to 12 hours after patient has received LMWH thromboprophylaxis.
3. Needle placement should be delayed at least 24 hours in patients receiving therapeutic LMWH.
4. In patients receiving twice daily dosing of LMWH:
   - Indwelling catheters should be removed before initiation of twice daily dosing regimen.
   - LMWH should be delayed for 2 hours after catheter removal.
5. In patients receiving single daily dosing of LMWH.
   - Catheters can be maintained in place.
   - Catheter can be removed no sooner than 10 to 12 hours after last dose of LMWH.
   - Subsequent LMWH should be withheld for two hours after catheter removal.
6. NSAIDs (including aspirin) alone do not add a significant risk for development of spinal hematoma.
7. Neuraxial anesthetic techniques should be avoided in patients who are receiving NSAIDS and LMWH.
8. These same recommendations apply for patients undergoing deep plexus or peripheral blocks.

APPENDIX H: SEDATION ORDERS

Allergies:_____Weight:_____kg

Diagnosis:_____

Service:_____Attending:_____

SEDATION ANALGESIA DELIRUM

See ICU Sedation Analgesia Delirium Algorithm

Nursing Orders

- ☐ Daily sedation Hold
  1. Hold sedation/analgesia daily.
  2. Assess pt for SBT if on ventilator.
  3. Restart sedation/analgesia at intermittent dosing;
  OR if patient's condition requires continuous infusion, restart infusion at ½ pre-interruption dose.
- ☐ Sedate to RASS goal of minus 2 to minus 1. See RASS scale. (Appendix D)
- ☐ ICU Sedation Analgesia Delirium Protocol.
  See CAM scale. (Appendix E)
  See Treatment Algorithm
- ☐ Notify MD
  For delirium prior to initiating pharmacologic treatment
  For patient on Clonidine - If SBP falls > 30 mmHg or DBP fall > 20 mmHg

ANALGESIA

Intermittent Dosing Start with Intermittent Dosing. If required more than Q 2 Hours, go to Continuous Infusion.

- ☐ fentanyl IV _____ mcg (25-100 mcg). Intravenous, EVERY 1 HOUR AS NEEDED for mild to moderate pain.
  Titrate pain medications to achieve a level 3 or _____ (pain scale 1-10).
  Start with Intermittent Dosing. If required more than Q 2 hours, go to Continuous infusion.
  Administer via slow IV.
- ☐ ketamine IV____mg (0.1-0.5 mg/kg). Intravenous, EVERY 1 HOUR AS NEEDED for mild to moderate pain.

Continuous Dosing Stop intermittent dosing if continuous infusion initiated and notify Pharmacy.

- ☐ fentanyl IV _____ mcg (25-250 mcg/hr), Intravenous, CONTINUOUS
  Titrate pain medication to achieve a level 3 or ____ (pain scale 0-10).
  Stop intermittent dosing if continuous infusion initiated and notify Pharmacy Services. **High-Risk Medication**
- ☐ fentanyl IV bolus _____mcg (25-100 mcg), Intravenous, EVERY 10 MINUTES AS NEEDED for breakthrough pain.
  Titrate pain medication to achieve a level 3 or ____ (pain scale 0-10).
  Administer via slow IV.
- ☐ ketamine IV _____mg (10-40 mg/ hr for ≥70 kg and < 60 years old) CONTINUOUS
  Titrate pain medication to achieve a level 3 or ____ (pain scale 0-10).
  Stop intermittent dosing if continuous infusion initiated and notify Pharmacy Services.
- ☐ ketamine IV_____mg (100 mcg/ kg/ hour) of ketamine CONTINUOUS
  Titrate pain medication to achieve a level 3 or ____ (pain scale 0-10).
  Stop intermittent dosing if continuous infusion initiated and notify Pharmacy Services.
- ☐ ketamine IV bolus 0.1-0.5 mg/kg , Intravenous, EVERY 10 MINUTES AS NEEDED for breakthrough pain.
  Titrate pain medication to achieve a level 3 or _____ (pain scale 0-10).

SEDATION: See RASS scale.

Intermittent Dosing Start with Intermittent Dosing. If required more than Q 2 hours, go to Continuous Infusion.

- ☐ lorazepam (aka ATIVAN) IV _____ mg (1-4 mg), Intravenous, EVERY 1 HOUR AS NEEDED for anxiety/agitation.
  Start with Intermittent Dosing. If required more than Q 2 hours, go to Continuous Infusion.
  Titrate sedation to RASS score of -1 to 0.

Continuous Infusion Stop intermittent dosing if continuous infusion initiated and notify Pharmacy.

- ☐ lorazepam (aka ATIVAN) IV infusion _____mg/hr (1-5 mg/hr), Intravenous, CONTINUOUS
  Stop intermittent dosing if continuous infusion initiated and notify Pharmacy.

Titrate sedation to RASS score of -1 to 0

☐ lorazepam (aka ATIVAN) IV bolus _____ mg (1-2 mg), Intravenous, EVERY 20 MINUTES AS NEEDED for breakthrough agitation/anxiety.
Titrate sedation to RASS score of -1 to 0

☐ midazolam (aka VERSED) IV infusion (avoid in renal/liver dysfunction) _____ mg/hr (1-6 mg/hr), Intravenous, CONTINUOUS.
Stop intermittent dosing if continuous infusion initiated and notify Pharmacy.
Titrate sedation to RASS score of -1 to 0

DEXMEDETOMIDINE: Continuous Infusion

☐ dexmedetomidine IV _____mcg/kg/hr (0.3-0.7 mcg/kg/hr), Intravenous, CONTINUOUS for 24 hours
1. Is rapid extubation expected (24-48 hrs)? Yes ☐ No ☐
2. Ordered by IC fellow or ICU staff? _____
3. Please select the indication (must meet one of the following):
   - ☐ Awake intubation ☐ BIPAP use requiring sedation
   - ☐ Bridge to extubation ☐ Desired light to moderate sedation

- Titrate in increments of 0.1 mcg/kg/hr Q 10 minutes to achieve a sedation score of 2-3 and pain score < 4/10.
- Do not exceed maximum dose of 0.7 mcg/kg/hr.
- Keep heart rate greater than ____ beats per minute and systolic blood pressure greater than ____ mmHg and mean arterial pressure greater than _____mmHg.
- Discontinue for heart rate < 45 beats per minute or if patient develops 2nd or 3rd degree Atrioventricular block.
- For persistent hypotension unresponsive to fluid challenge, decrease the rate by 50%.
- Discontinue if systolic blood pressure and mean arterial pressure do not return to parameters specified above in 10 minutes. Call physician for further instructions.

DELIRIUM: See CAM scale

Initiating Therapy

☐ haloperidol (aka HALDOL) IV x 1 _____mg (2-10 mg), Intravenous, ONCE For 1 Dose Administer over 1 minute. See CAM scale.

☐ haloperidol (aka HALDOL) IV PRN _____mg (2-5 mg), Intravenous, EVERY 15 MINUTES AS NEEDED for agitation.
Recommend not to exceed 20 mg over one hour.
Slow administration over 5-10 minutes preferred to minimize hypotension. See CAM scale.

Maintenance Dosing QTc monitoring required for patients receiving more than 10 mg haloperidol per day

☐ haloperidol (aka HALDOL) IV _____ mg (2-5 mg), Intravenous, EVERY 1 HOUR AS NEEDED for delirium.
Not to exceed dose 80 mg IV in 24 hours.
Slow administration over 5-10 minutes preferred to minimize hypotension. See CAM scale.

☐ quetiapine (aka SEROQUEL) PO tablet (Day 1) 25 mg, Oral, TWICE DAILY. See CAM scale.

☐ quetiapine (aka SEROQUEL) PFT tablet (Day 1) 25 mg, Feeding tube, TWICE DAILY. See CAM scale.

☐ quetiapine (aka SEROQUEL) PO tablet (Day 2) 50 mg, Oral TWO TIMES DAILY.
If patient responds to initial dose and PO/PFT available. See CAM Scale.

☐ quetiapine (aka SEROQUEL) PFT tablet (Day 2) 50 mg Feeding tube, TWO TIMES DAILY.
If patient responds to initial dose and PO/PFT available. See CAM scale.

☐ clonidine (aka CATAPRES) tablet PRN 0.1-0.2 mg, Oral EVERY 1 HOUR AS NEEDED for hypertension due to agitation.
- May repeat x 3 doses as needed, until SBP ≤ 140 mmHg (160 mmHg if over 65 years of age).
- If blood pressure goal is not achieved with clonidine 0.1 mg, give clonidine 0.2 mg every 1 hour as needed to achieve SBP ≤ 140 mmHg (160 mmHg if over 65 years of age).
- Once BP goal is met, move to maintenance and/or PRN dose.
- Hold clonidine if systolic blood pressure falls more than 30 mmHg of diastolic blood pressure falls more than 20 mmHg and notify physician.

☐ clonidine (aka CATAPRES) tablet scheduled 0.1-0.2 mg, Oral, EVERY 8 HOURS
Administer until SBP < 140 mmHg then change to maintenance/PRN dose.
Hold clonidine if systolic blood pressure falls more than 30 mmHg or diastolic blood pressure falls more than 20 mmHg and notify physician.

APPENDIX I: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires DoD health care practitioners consider it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Pelvic Fracture Care (CPG ID: 34)

Provides a brief review for the stabilization and treatment of pelvic fractures sustained in combat casualties.

Contributors

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Updated with aeromedical evacuation considerations, 26 Feb 2020.

BACKGROUND

Historically, injuries to the bony pelvis were relatively uncommon in the combat environment. The prevalence of Improvised Explosive Device (IED) attacks seen in the Iraq and Afghanistan operations against technologically improved tactical vehicles, as well as during dismounted operations, has led to an increased incidence of blunt trauma pelvic injuries.[1] The patterns of pelvic fracture in the combat environment tend to be more complex, more difficult to classify, and more commonly open than those seen in civilian trauma.

Hemodynamically compromised patients with pelvic fractures present a complex challenge to the trauma team as sharp spikes of bone resulting from pelvic ring injuries can lacerate surrounding soft tissues and induce brisk bleeding. The most common sources of bleeding are from fracture surfaces and the retroperitoneal venous plexus, with gluteal artery injuries occurring less commonly.[2, 3] Also at risk are the hollow visceral contents of the abdomen and pelvis, L5 nerve root, and lumbar plexus.

Pelvic fractures often occur in conjunction with other life threatening injuries. Civilian mortality rates have ranged from 6-35% with higher mortality rates associated with open fractures.[4-8] Death within the first 24 hours of injury in these patients is most often a result of **acute blood loss and associated injuries**.[8]

Recent analysis of mortality with combat related pelvic fractures identified large vessel injury, head injury, and injury to solid abdominal organs as risk factors for mortality in the setting of combat related pelvic ring injuries.[9] **Open pelvic fractures** in the combat environment have become more common most likely secondary to the increased prevalence of blast mechanisms of injury, combined with better patient survivability - attributed to rapid transport to surgical stabilization, use of tourniquets, the use of enhanced body armor and more aggressive massive transfusion protocols. These open fractures are often associated with other severe injuries, including lower extremity amputations. Combat related pelvic ring injuries are commonly high-energy and unstable injuries, frequently requiring operative fixation.

EVALUATION AND TREATMENT

NOTE: *Refer to Appendix A.*

1. Key issues in management of pelvic fractures are to identify if the patient is hemodynamically stable and if the pelvic fracture is mechanically stable. If the patient is not hemodynamically stable, it is imperative to identify all site(s) of hemorrhage as pelvic fractures often occur in conjunction with other life threatening injuries. Appropriate **evaluation of the abdomen, chest, and other potential sites of injury and hemorrhage** cannot be overstressed. Additionally, a **thorough examination of the pelvis and perineum** is required to rule out associated injuries to the rectum and genitourinary/gynecologic systems. Pelvic fracture is a common component of Dismounted Complex Blast Injury.[10]

2. When pelvic fractures cause hemorrhage, the bleeding occurs from three major sources: arterial, venous, and cancellous bone. Over 70% of hemorrhage associated with blunt pelvic trauma causing pelvic fracture is venous in nature and may be controlled with maneuvers that reduce the pelvic volume and stabilize the pelvis.[11] The other nearly 30% is associated with an arterial source and often requires procedural interventions such as **surgical packing and/or embolization**.[12] **Pelvic packing** can be a valuable technique, particularly when the patient is in extremis, or when laparotomy is required for associated injuries.[13]

3. In the austere environment, if open pelvic fractures continue to bleed despite retroperitoneal packing, bilateral internal iliac artery ligation should be considered.[14] In these dire circumstances, temporary cross-clamping of the aorta may help **control life-threatening hemorrhage** prior to dissection and ligation of the internal iliac arteries.

4. For pelvic fractures, **initial stabilization** with whatever means are available (sheet, pelvic binders, bean or sand bags, or pelvic external fixation) must be promptly implemented. In the combat environment, when fracture stability is unclear and specialist expertise is not available to determine pelvic fracture stability, stabilization with a sheet or binder is recommended. When possible, taping the knees and ankles together can minimize additional external rotational movement, and help improve the pelvic reduction achieved with a sheet or binder. Pelvic binders are correctly placed by centering over the greater trochanter of the femur, applying an internal rotational force to each hemi-pelvis through the hip joints.

5. The establishment of **standardized clinical treatment algorithms** for patients with pelvic fractures has been shown to greatly increase the probability of rapid stabilization of trauma patients.[15-18] Appendix A shows an algorithm in unstable patients.

6. A **multidisciplinary approach with early trauma surgery and orthopedic surgery coordination** is critical. The focus of the evaluation and treatment is early identification of injury with early mechanical stabilization as necessary and determination of hemodynamic instability with aggressive resuscitation for hemorrhage. When available, angiographic exploration with early embolization by skilled interventionalist for the hemodynamically unstable patient with intrapelvic hemorrhage may be beneficial-preferably in the operating room.[19]

7. Given that this capability is rarely available outside of a Role 3 facility, the next most beneficial maneuver is **retroperitoneal packing via a suprapubic incision**.[20,21] The temptation to open a retroperitoneal pelvic hematoma (as a result of a pelvic fracture) from inside the abdomen should be resisted and attempted only as a last resort although this may be necessary due to other intra-abdominal or pelvic injuries. In the casualty who remains hemodynamically compromised in spite of these efforts bilateral iliac artery ligation should be considered.[14] However, these interventions should not delay the necessary acute surgical treatment for concomitant hemorrhagic injuries.

AEROMEDICAL EVACUATION CONSIDERATIONS

1. Ensure fracture stabilized prior to transport.

2. Patient should be hemodynamically stabilized, with no evidence of active bleeding prior to transport. Coordinate with Theater Validating Flight Surgeon for exceptions.

3. Vibration in flight will increase pain. Ensure adequate pain control by ordering additional breakthrough pain medications.

4. Consider DVT prophylaxis. See the JTS Prevention of Deep Venous Thrombosis– Inferior Vena Cava Filter CPG, 02 Aug 2016.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Patients diagnosed with pelvic fracture.

INTENT (EXPECTED OUTCOMES)

1. Patients in the population of interest with hemodynamic instability (SBP < 100 or HR >100) receive pelvic stabilization (binder or external fixation).

2. Pelvic fracture patients who remain hemodynamically unstable after 2 units of blood product transfusion undergo hemorrhage control procedure at the same level of care where diagnosed (exploratory laparotomy, preperitoneal packing, REBOA, and/or interventional angiography embolization).

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with hemodynamic instability (SBP < 100 or HR >100) who receive pelvic stabilization (binder or external fixation).

2. Number and percentage of patients with pelvic fracture who remain hemodynamically unstable after 2 units of blood product transfusion undergo hemorrhage control procedure at the same level of care where diagnosed (exploratory laparotomy, preperitoneal packing, REBOA, and/or interventional angiography embolization).

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Director and the JTS Performance Improvement Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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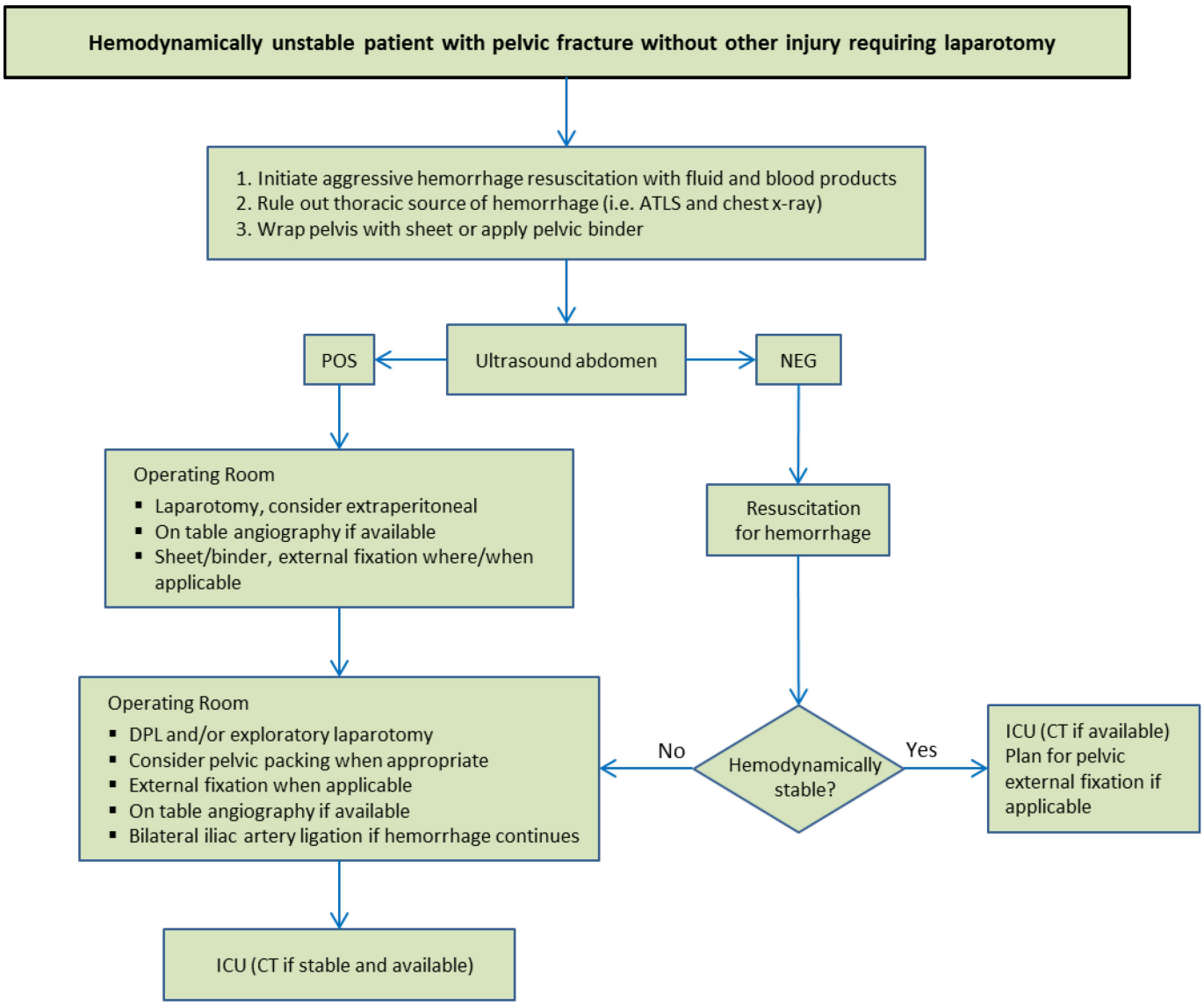
APPENDIX A: PELVIC FRACTURE CLINICAL PATHWAY


Hemodynamically unstable patient with pelvic fracture without other injury requiring laparotomy
1. Initiate aggressive hemorrhage resuscitation with fluid and blood products
2. Rule out thoracic source of hemorrhage (i.e. ATLS and chest x-ray)
3. Wrap pelvis with sheet or apply pelvic binder
Ultrasound abdomen
POS
NEG
Operating Room
Laparotomy, consider extraperitoneal
On table angiography if available
Sheet/binder, external fixation where/when applicable
Resuscitation for hemorrhage
Operating Room
DPL and/or exploratory laparotomy
Consider pelvic packing when appropriate
External fixation when applicable
On table angiography if available
Bilateral iliac artery ligation if hemorrhage continues
No
Hemodynamically stable?
Yes
ICU (CT if available) Plan for pelvic external fixation if applicable
ICU (CT if stable and available)

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

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With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Prehospital Blood Transfusion

The CPG provides a brief summary of the scientific literature for prehospital blood use and essential instructions on resuscitation procedures using blood products.

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Rapid Update, Jun 2023: *Calcium administration changed to 1 gram calcium*

PURPOSE

This Clinical Practice Guideline (CPG) provides a brief summary of the scientific literature for prehospital blood use, with an emphasis on the en route care environment. Updates include the importance of calcium administration to counteract the deleterious effects of hypocalcemia, minimal to no use of crystalloid, and stresses the importance of involved and educated en route care medical directors alongside at a competent prehospital and en route care providers (See Table 1.) With the paradigm shift to use FDA-approved cold stored low titer group O whole blood (CS-LTOWB) along with the operational need for continued use of walking blood banks (WBB) and point of injury (POI) transfusion, there must be focused, deliberate training incorporating the different whole blood options. Appropriate supervision of autologous blood transfusion training is important for execution of this task in support of deployed combat operations as well as other operations in which traumatic injuries will occur. Command emphasis on the importance of this effort as well as appropriate logistical support are essential elements of a prehospital blood program as part of a prehospital/en route combat casualty care system.

Table 1. Five Levels of Clinical Competence

Five Levels of Clinical Competence		
Skill Level	**Description**	**Trauma-related Example**
Novice	The novice has no experience in the environment in which they are expected to perform.	Administrator or technician who has never worked in a trauma center.
Advanced Beginner	The advanced beginner demonstrates marginally acceptable performance and has enough experience to note recurrent meaningful situational components.	Medic that has had didactic trauma training but no clinical trauma experience.
Competent	Competence is achieved when one begins to see one's actions in terms of long-range goals or plans. This individual demonstrates efficiency, coordination, and confidence in his/her actions.	Board eligible/certified physician, newly trained nurse, but has only rotated as a learner at a trauma center.
Proficient	The proficient individual perceives situations holistically and possesses the experience to understand what to expect in a given situation.	Board eligible/certified physician or newly assigned nurse with limited but recent prior exposure to trauma, starting their career at a high volume and best quality Level I trauma center.
Expert	The expert has an intuitive and deep understanding of the total situation and is able to deliver complex medical care under highly stressful circumstances.	Trauma nurse coordinator, Board certified Emergency Physician or fellowship trained trauma surgeon/intensivist with years of experience at a high volume and best quality Level I trauma center.

Sources: Adapted from Benner, 1982; Dreyfus, 1981; Dreyfus and Dreyfus, 1980.

INTRODUCTION

Early administration of blood products to the trauma patient in extremis is the standard in combat casualty care and becoming more common as part of a strategy of civilian prehospital critical care.[1-7] Although there is some dissent regarding the level of evidence for and benefits of prehospital blood transfusion in the civilian literature, much of the data informing that discussion precedes the use of whole blood and involves a patient population dissimilar from the military.[8,9] Civilian Emergency Medical Services systems internationally[10,11] and in Texas, North Carolina and several other states have initiated whole blood transfusions in the prehospital environment. At least one civilian tactical law enforcement team has initiated a Low-Titer O Fresh Whole Blood program.[12] The main military literature covering this topic is summarized in Table 2 below.

Table 2. Military literature on prehospital transfusion

Article	Setting	Inclusion	Findings	Comments
Shackelford SA, Del Junco DJ, Powell-Dunford N, et al. **Association of prehospital blood product transfusion during medical evacuation of combat casualties in Afghanistan with acute and 30-day survival.** JAMA. 2017;318(16):1581-91.	Mostly Military air ambulance evacuations	1) Traumatic limb amputation at or above the knee or elbow or 2) Shock defined as a systolic blood pressure of less than 90 mm Hg or a heart rate greater than 120 beats per minute.	Adjusted hazard ratio for mortality associated with prehospital transfusion was 0.26(95%CI, 0.08 to 0.84,P=.02) over 24 hours (3 deaths among 54 recipients vs 67 deaths among 332 matched nonrecipients) and 0.39(95%CI,0.16 to 0.92,P=.03) over 30 days(6 vs 76 deaths, respectively)	
Malsby RF, 3rd, Quesada J, Powell-Dunford N, et al. **Prehospital blood product transfusion by U.S. army MEDEVAC during combat operations in Afghanistan: a process improvement initiative**. Mil Med. 2013;178(7):785-91.	Military air ambulance in Afghanistan	Traumatic injury (chest/abd and single or multiple amputations) with 1) systolic blood pressure (SBP) <90 mmHg 2) heart rate (HR) >120 bpm 3) Oxygen Saturation (SaO2) <90%.	Feasibility study showed: 15 patients given 19 units no adverse reactions and no instances of blood product temperature outside of the accepted range	
O'Reilly DJ, Morrison JJ, Jansen JO, et al. **Prehospital blood transfusion in the en route management of severe combat trauma: a matched cohort study**. J Trauma Acute Care Surg. 2014;77 (3 Suppl 2):S114-20.	Regional Command South in AFG by MERT	MERT Physician order based upon injury severity and blood product availability	Matched cohort study of 1,592 patients in Afghanistan transported by a prehospital intensivist team found mortality significantly lower in those patients who received prehospital blood transfusions than those who did not (8.2% vs 19.6%, p<0.001	Confounded by different rates of invasive procedures

Prehospital blood transfusions during an eight-month period in one system were reviewed and found to be logistically complex but practically possible with repetitive training.[13] In another investigation, 15 patients safely received a total of 19 units of blood products according to pre-established guidelines for blood product transfusion in U.S. Army Medical Evacuation (MEDEVAC) units in Afghanistan.[14] Inclusion criteria for initiation of prehospital blood transfusion were: traumatic injury with systolic blood pressure (SBP) <90 mmHg or heart rate

(HR) >120 bpm or Oxygen Saturation (SaO2) <90%. Following the fifth transfused unit, oxygen saturation was excluded as a transfusion trigger and multiple amputations (with at least one proximal amputation) were included as transfusion triggers. There were no adverse reactions and no instances of blood product temperature outside of the accepted range.

Advanced clinical care during patient transport has demonstrated improved outcomes.[15-17] A growing body of evidence suggests that early blood transfusion, both at point of injury and en route to a surgical capability improves survival in severely injured patients with acute blood loss. Rapid initiation of blood transfusion among wounded personnel in Afghanistan was evaluated among 502 patients.[18] Patients who had been transported via MEDEVAC; who had suffered a traumatic amputation at/above the knee/elbow; had SBP <90 mmHg or HR >120 bpm; and who had received blood products during transportation, or, shortly after arrival in the hospital, were compared to those who did not receive blood. Those who received blood were significantly less likely to die at 24 hours (adjusted hazard ratio for mortality 0.26 [95% CI 0.08-0.84, p=0.02]) as well as at 30 days (adjusted hazard ratio for mortality 0.39 [95% CI 0.16-0.92, p=0.03]). This study underscores the importance of early transfusion. The en route care providers must continue (or in some cases start) transfusion as soon as the casualty is in the aircraft. Blood products that have started transfusion at POI can be continued during MEDEVAC.

A matched cohort study of 1,592 patients in Afghanistan transported by a en route care intensivist team found mortality to be significantly lower in those patients who received prehospital blood transfusions than those who did not (8.2% vs 19.6%, p<0.001).[19] Several confounding variables make these data difficult to interpret (e.g., differing rates of prehospital rapid sequence induction, administration of pharmacologic adjuncts and varied transportation times). Nevertheless, it is likely that an aggressive approach to prehospital critical care including blood transfusion was part of an overall strategy of damage control resuscitation that improved survival in severely injured patients.

PREHOSPITAL PRINCIPLES OF RESUSCITATION AND TRANSFUSION

- Rapid recognition of life-threatening hemorrhagic shock
  - Point of care devices if available: international normalized ratio; lactate level may be of value.
- Prevent hypothermia
- Hemorrhage control with mechanical hemostatic adjuncts:
  - Tourniquet/junctional tourniquet
  - Pressure dressings/thrombin and fibrin impregnated gauze
- Hemostatic Resuscitation
  - Whole blood (WB) is optimal
    1. FDA approved CS-LTOWB
    2. Low titer group O whole blood (LTOWB)
    3. Type O-WB (non-titered)
    4. Component therapy with plasma (dried, liquid, or, thawed), red blood cells (RBCs), and platelets in 1:1:1 ratio
- Avoid hypocalcemia/Calcium replacement

  - In prolonged evacuations, empiric calcium administration for every 4-6 units of RBCs or WB
- Avoid crystalloid resuscitation
- Tranexamic Acid administration if less than 3 hours from time of injury
- Consider source of freeze-dried plasma if available

***NOTE**: Conventional goal is systolic blood pressure >90mmhg. Recent concept indicates a higher goal of 90-110mmHg due to shift towards blood-based resuscitation and concern for prolonged hypoperfusion especially for patients with long transport times.*

CRITERIA FOR TRANSFUSION

Prehospital blood transfusion is predicated upon clearly defined criteria for the use of this valuable resource. Several high performing military and civilian prehospital medical teams use prehospital blood transfusion according to protocolized guidelines. The U.S. Army Ranger Regiment was an early adopter of prehospital blood transfusion and uses the following criteria for transfusion: signs and symptoms of hemorrhagic shock; OR 1+ amputation; blunt/penetrating trauma (junctional/abdominal/thoracic); OR pelvic fracture; OR SBP <100; OR lactate >5; pulse >100.[20] In Australia, the Greater Sydney Area Helicopter Emergency Medical Services (GSA-HEMS) is an intensivist-based prehospital critical care service that has extensive experience in prehospital blood transfusion. In the prehospital environment, they transfuse blood if there is "persistent hemorrhagic shock despite hemorrhage control measures after crystalloid infusion."[21] During interhospital transport GSA-HEMS transfuses blood if there is "persistent hemorrhagic shock where there is limited or no access to cross-matched blood and [an] ongoing requirement for transfusion." The Australian Queensland Ambulance Service Trauma Response Team administers blood products in the prehospital environment and a retrospective review of cases was published in 2014 demonstrating benefit in appropriate clinical situations.[22] In 2014, proposed criteria for prehospital blood products in combat casualties were refined based on data from Afghanistan[23] and updated in 2020 using a larger data set from the entire DoD Trauma Registry (DoDTR).[24] A case series reviewing the benefits of early whole blood administration in combat casualties was published in 2016.[25]

Development of transfusion criteria is an important consideration in establishment of a prehospital transfusion program. In the civilian trauma center experience, 596 trauma patients were evaluated using an assessment of blood consumption (ABC) score.[26] Patients received one point for any of the following: penetrating mechanism; positive focused assessment sonography for trauma (FAST); systolic blood pressure less than 90 mmHg; heart rate greater than or equal to 120 beats per minute. An ABC score of two or greater predicted the need for massive blood transfusion with 75% sensitivity and 86% specificity. This investigation demonstrated the utility of a quick, non-laboratory based tool to predict the need for blood transfusion.

Careful attention to transfusion triggers can limit wastage of this important resource in a potentially resource constrained environment. Furthermore, it is important to note that blood product usage can be optimized when hemorrhage control is undertaken simultaneously.[5,7] Ensure that hemorrhage control efforts are properly employed in accordance with Tactical Combat Casualty Care Guidelines. When administering blood, be certain to alert the receiving facility that the patient is requiring blood transfusion, noting any potential need for massive transfusion.

PROCEDURE

Certain special considerations for blood transfusion have been enacted in other Department of Defense transfusion algorithms.[27] Rapid transfusion of blood can cause sheering of RBCs and should be avoided if possible. When possible, low titer group O whole blood (LTOWB) should be administered as the blood product of choice. LTOWB has been screened for Anti-A and Anti-B antibodies. The titer of these antibodies is low enough to represent minimal risk of clinical consequences and may be considered a universal donor. LTOWB will be exclusively drawn from sites approved by the Armed Services Blood Program (ASBP), distributed in theater via the ASBP blood distribution system and fully tested in accordance with FDA guidelines.

Blood products should be transfused in a plasma:platelet:RBC ratio of 1:1:1. If platelets are not available, then plasma:RBC should be transfused in a 1:1 ratio. If that is not possible, then reconstituted dried plasma, liquid plasma or thawed plasma alone or RBCs alone should be transfused.

If available, type O negative RBCs should be used preferentially for females of childbearing years. If it is necessary to administer O positive blood to a woman of childbearing years with O negative blood, then consider Rhogam therapy to decrease the risk to subsequent pregnancies. Please note though that resuscitation and prevention of exsanguination takes precedence of potential future pregnancy complications. Pediatric blood transfusion should be based on clinical signs of shock rather than predefined vital signs, since vital signs can vary considerably between age groups in pediatric patients.

Blood plasma contains important clotting factors and can be transfused rapidly. Thawed plasma has a shelf life of 5 days and may not be available for prehospital missions. “Never frozen” liquid plasma has a shelf life of 26 days and may be more readily available. Check with the issuing facility for availability of thawed or liquid (i.e. never frozen) plasma. All blood products must be transfused immediately after removal from the storage container. If transfusion is delayed, then blood products that have been removed from storage and exceeded proper temperature will be returned to the issuing facility per local policy. Ensure that all blood products issues have a Safe-T-VUE (NSN 6515-08-T00-3056) attached and activated for temperature monitoring.
(See Appendix E).

QUALITY CONTROL

Proper storage, transport and administration of blood and blood products is addressed the following Joint Trauma System CPGs: Damage Control Resuscitation,[28] Frozen and Deglycerolized Red Blood Cells[29] and Whole Blood Transfusions.[30]

Ensure that the blood product container (NSN 6530-01-505-530I; OCP/5306; Desert) is properly charged and maintained prior to loading blood products. Ensure that all blood products have a Safe-T-VUE attached and activated for temperature monitoring. Ensure that thawed plasma is at a refrigerated temperature (1-6 degrees C) prior to placement of Safe-T-VUE. Appropriately document issuance and use of blood products per local protocol, including documentation in Theater Medical Data Store (TMDS) inventory.

Blood products carried outside of a medical treatment facility (MTF) and/or laboratory will be contained in an approved storage container for a maximum of 48 hours. Once loaded and sealed, a container will remain closed and intact until used for patient care or returned to the issuing facility. Units will inspect blood product containers and document appropriate quality metrics (e.g., intact, no leaking) every 24 hours.

TRANSFUSION REACTION

The rate of non-infectious transfusion reaction is low.[31] In a recent evaluation of 4,857 transfusion episodes approximately 1% were associated with a serious reaction.[32] Transfusion-associated circulatory overload was most common (~1%); while transfusion-related acute lung injury, anaphylactic reaction and hypotensive reactions all occurred in less than 0.1% of transfusions. Other investigators evaluated emergency transfusion of 5,203 units of type-O RBC to 480 trauma patients and found that no acute hemolytic transfusion reactions occurred.[33]

In the unlikely event of a prehospital transfusion reaction, immediately stop the transfusion. In cases of anaphylaxis, administer 0.3 mL of 1:1000 epinephrine intramuscularly (IM), administer diphenhydramine 25 mg IV or IM and consider methylprednisolone (the FDA approved dose of methylprednisolone is 10 – 40 mg IV over several minutes, with subsequent doses being determined by clinical response). Maintain the patient's airway as needed and administer IV fluids in cases of hypotension. In cases of acute hemolytic reaction, administer diphenhydramine 25 mg IV or IM, and consider osmotic diuresis with mannitol 20% 20 gm or 3% sodium chloride 250 mL.

HYPOCALCEMIA

Calcium administration should be considered in all patients undergoing en route care blood transfusion. The citrate preservative in blood products can chelate calcium and contribute to hypotension in patients who have received blood products.[34] In 352 patients who were critically bleeding and required massive transfusion, investigators found that hypocalcemia worsened mortality. Patients generally had low ionized calcium concentration (mean = 0.88mmol/L) and had higher odds of mortality (Odds Ratio = 1.25, 95% Confidence Interval 1.04-1.52; P = 0.02). Admission hypocalcemia is further associated with mortality.[35] Calcium concentration was measured in 591 trauma patients before administration of blood products. Those with an ionized calcium < 1 experienced higher mortality (15.5%) compared to those with ionized calcium levels >1 (mortality = 8.7%, p = 0.036).

Trauma patients are often hypocalcemic without regard to transfusion status, further suggesting that calcium administration may be beneficial.[36,37] In 212 trauma patients with a mean Injury Severity Score (ISS) of 34; 64% were found to be hypocalcemic (with calcium < 1.15 mmol/L) and 10% were severely hypocalcemic (<0.9mml/L). Hypocalcemia is common in massive transfusion and associated with increased mortality.[38,39] Although the mechanism of this effect is not completely understood, it is thought that acidemia related to tissue hypoperfusion may play a role.[40] Administration of one gram of calcium-IV/IO before, during (using a secondary access point) or immediately after the first unit of blood product. Re-dose one gram of calcium IV/IO after every 4 units of blood products.

TRAINING

Execution of prehospital and en route care blood transfusions requires sufficient training to adequately prepare. Conducting the most realistic training possible has been shown to improve in-hospital trauma team performance as well as the widely held belief of military training in general. Whole blood training should be viewed similarly.[41] Coordinated and deliberate autologous blood labs with appropriate oversight can safely achieve the highest degree of realism with relatively low cost.[42,43] Armed services blood bank policies for donor allowance in autologous blood lab participants is still under discussion.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All patients who receive blood product transfusion within 3 hours of injury
2. All patients who meet criteria for blood transfusion (severe traumatic injury: ISS ≥16 and ≥ 2 body regions injured with AIS severity ≥ 2 AND SBP < 100 OR HR > 100 OR hematocrit < 32% OR pH <7.25) within 3 hours of injury

INTENT (OUTCOME)

1. LTOWB is used for prehospital resuscitation of casualties with life-threatening injuries and hemodynamic instability (HR > 100 or SBP < 100).
2. For the population of interest, the first resuscitation fluid given after injury is a blood product, ideally cold-stored LTOWB.
3. Administration of whole blood and blood products to appropriate combat casualties in the prehospital and en route care environment.

PERFORMANCE/ADHERENCE METRICS

1. The number and percentage of patients in the population of interest who receive WB transfusion prior to arrival at first role of care.
2. Number and percentage of patients in population of interest who received a blood product as the first resuscitation fluid.
3. Number and percentage of patients in population of interest who received cold-stored LTOWB as the first resuscitation fluid.
4. Indication identified.
5. Pre and post vital signs measured.
6. Calcium administration documented.
7. Appropriate information collected for donor and recipient exposure monitoring.

DATA SOURCES

- Patient Record (DD1380/DA4700 OP7)
- DoDTR

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting frequency will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Improvement Branch.

RESPONSIBILITIES

It is the Unit Medical Director's responsibility to ensure familiarity, training, appropriate compliance and PI monitoring at the local level with this CPG. Coordination with the Regional Medical Director and Trauma Director is also essential in ensuring full spectrum compliance and PI monitoring along with clear communication with the Combatant Command Trauma System and Joint Trauma System.

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APPENDIX A. PREHOSPITAL BLOOD TRANSFUSION PROCEDURES

BEFORE

Criteria for Blood Transfusion:

- HR >100 bpm; or
- SBP <100 mmHg or no radial pulse; or
- Altered mental status with signs/symptoms hemorrhagic shock; or
- Penetrating trauma to chest/abdomen, junctional injuries; or
- Pelvic fracture; or
- Any above knee amputation or multiple amputations (regardless of vital signs)

DURING

1. **Obtain IV/IO access**
   a. Verify blood product identification number
   b. Connect IV tubing with filter to blood
   c. Transfuse as rapidly as tolerated
2. **Monitor for signs of transfusion reaction:**
   Hypotension, flushed face, wheezing, fever, rigors, flank pain
   - Anaphylaxis = Epinephrine 0.3 mL of 1:1000 IM; Diphenhydramine 25 mg IV/IM; Maintain airway; Administer IV fluids prn; Consider Methylprednisolone
   - Acute hemolytic reaction = Diphenhydramine 25 mg IV/IM; Consider osmotic diuresis with 20 gm mannitol 20% or 250 mL 3% NaCl

AFTER

Resupply from pre-designated source: Consider 1 gram calcium IV

***Abbreviations**: Heart rate (HR), Beats per minute (bpm), Systolic blood pressure (SBP), Intravenous (IV), Intraosseous (IO), Intramuscular (IM), As needed (prn), Gram (gm), Sodium chloride (NaCl)*

APPENDIX B: RESUSCITATION USING BLOOD PRODUCTS DURING TACEVAC

Source: Vampire Program: CENTCOM Clinical Operations Protocol-01: Urgent Resuscitation using Blood Products during Tactical Evacuation from Point of Injury

PURPOSE

To provide essential instructions on urgent/life-saving resuscitation procedures using blood products during tactical evacuation (refers to both casualty evacuation and medical evacuation) from the point of injury (POI) for casualties suffering major blood loss/massive hemorrhage. Referred to as the *Vampire Program.* This guideline supports the Joint Trauma System (JTS) Damage Control Resuscitation Clinical Practice Guideline (CPG), Whole Blood Transfusion CPG, and the Tactical Combat Casualty Care (TCCC) Guidelines.

Guidance applies to medical and non-medical personnel (e.g., flight medic, crew chief, registered nurse, enlisted medical personnel, physician, nurse practitioner, or, physician assistant), assigned/attached or allocated to perform tactical medical response (TCCC) and evacuation (CASEVAC and MEDEVAC) duties that involve direct or indirect patient care.

FIELD INDICATIONS FOR TRANSFUSION DURING TACTICAL EVACUATION

The following are indications for transfusion in the presence of severe traumatic injury:

- Systolic BP <100 or absence of radial pulse; or
- Heart rate >100; or
- Any above knee amputation or double/triple/quadruple amputation (regardless of vital sign indication).

WARNING*: The amputation patterns above are the only traumatic injuries that constitute a stand-alone immediate field indicator for transfusion that requires no confirmation with vital sign parameters.*

CAUTION*: Control external bleeding before or simultaneously with initiation of blood product transfusion.*

Traumatic Arrest: patient with exsanguination who had signs of life when received from ground forces and has since become pulseless should receive immediate transfusion (transfusion is more important than chest compressions in cases of exsanguination and should take priority).

Traumatic injuries where early blood transfusions are most likely to be needed:

- Penetrating thoracic/abdominal/junctional (junctional includes axilla/inguinal/cervical) injury.
- Pelvic fracture.
- Multiple injuries.
- Proximal amputations (above knee or elbow). Amputation is defined as any severe trauma to a limb that involves complete or partial loss of the limb (this includes limbs that are severely mangled but not completely severed).

Initiate transfusion with 1 unit of blood product. Give additional units if clinically indicated. Avoid resuscitation with crystalloid which may increase bleeding, particularly from non-compressible torso hemorrhage.

Refer to Appendix C for list of clinical indicators for hemorrhagic shock.

PROCEDURE

Blood Component Therapy Approved for Transfusion during Tactical Evacuation

Red blood cells (RBCs) increase the recipient's oxygen-carrying capacity by increasing the mass of circulating red cells. Plasma and platelets work together to improve blood clot formation and clot stability. On average a unit of whole blood (WB) contains a volume of 500-600 mL and a unit of RBC's contains a volume of 300-400 mL. In an exsanguinating patient, a unit of blood can be given quickly. Ensure good blood flow through IV or IO access before initiating transfusion. Refer to Appendix D for Transfusion Procedures and Appendix F for Pearls for Transfusion.

***CAUTION**: Rapid infusion against resistance can cause mechanical shearing of RBCs and should be avoided.*

1. Blood products will be administered in the following priority depending on availability and according to TCCC Guidelines:
    a. Cold Stored Low titer Group O whole blood (LTOWB), or, if not available
    b. Fresh Low titer Group O whole blood (LTOWB), or, if not available
    c. Plasma, RBCs, and platelets in a 1:1:1 ratio, or, if not available
    d. Plasma and RBCs in 1:1 ratio, or, if not available
    e. Reconstituted dried plasma, liquid plasma, or, thawed plasma alone or RBCs alone, or, if not available
    f. Fresh group O (typed by Eldon card or equivalent) whole blood from unknown titer walking blood bank

    ***NOTE**: LTOWB has been screened for anti-A and anti-B antibodies; these units contained a low titer of anti-A and anti-B and are therefore considered a universal donor product that may be given to recipients of any blood type with a minimum risk for a minor ABO incompatibility (typically minor and most often subclinical clinical consequences). The whole blood supplied to MEDEVAC units will be exclusively drawn in the United States from the ASBP-approved sites and distributed in theater by the ASBP blood distribution system. The LTOWB units will be fully tested following FDA current guidelines.*

2. POS (either low titer Group O WB or Type O RBCs) is the standard for transfusion during evacuation.

> ***NOTE**: Patients requiring blood can safely receive un-cross matched low titer Group O WB or Type O RBCs until type-specific products are available.*

3. If available, use O NEG on females of childbearing potential age <50 years old. Inform receiving facility regarding female given O POS blood for documentation in the medical record. If a minimal amount (just a few milliliters) is given, consider Rhogam therapy. The immunologic consequences of administration of an entire unit of O POS whole blood or RBC to an O NEG female of child-bearing potential cannot safely be reversed with Rhogam. Treatment of exsanguination takes precedence over potential future pregnancy outcomes.

> ***CAUTION**: WB collected in theater will NOT be supplied for use onboard MEDEVAC aircraft.*

Plasma is recognized as an important component in preventing and treating coagulopathy in trauma. On average a unit contains a volume of 200-250 mL and is transfused rapidly.

1. Type A or AB thawed plasma is the current standard for transfusion during evacuation.
2. Thawed plasma only has a shelf life of 5 days and may not be available for the pre-hospital mission. Liquid plasma (never frozen) has a shelf life of 26 days. Check with issuing facility or blood supply unit for availability.

The recommended mission loads for tactical evacuation are based on operations tempo and determined by the theater or Joint Task Force surgeon. Specific missions may require additional blood products; units will refer to the Joint Blood Program Office.

1. Golden Hour Container (GHC) maximum capacity is 4 units RBC/FFP or 2 units of whole blood.
2. If whole blood or plasma is unavailable, evacuation personnel will fly with RBCs exclusively.
3. Product must finish infusion within 4 hours of spiking the bag. If not complete, then it needs to be stopped and the remainder of the product discarded. If the initiation of transfusion (spiking of the bag) is delayed, then the blood may be returned to storage if it hasn't exceeded appropriate transport temperature, which is a max of 10C. The only way this can be determined is with use of a Safe-T-Vue sticker on the actual blood bag.
4. Unused blood products (i.e. WB and freeze dried plasma [FDP]) furnished by forward U.S. or Coalition Forces will not be used by evacuation personnel. Recommend products be left with forward forces. Blood products (WB and FDP) spiked by forward forces and transfusing at time of pick up will be continued during evacuation.

Pediatric patients:

1. Emergency transfusion of pediatric patients relies on clinical assessment rather than specific vital signs, since normal heart rate and blood pressure are age-dependent.
2. Clinical signs of shock are the same as in adults (cool, pale, weak or absent radial pulse, delayed capillary refill, decreased mental status).
3. Pediatric fluid resuscitation related to trauma begins with 10 mL/kg of first blood product, then repeat as needed based on response.

Receiving Blood Components from an Issuing Facility (U.S. and Coalition)

U.S. issuing facility personnel from the Blood Support Detachment (BSD), MTF (Role 2/3) or lab will:

1. If requested and available, thaw frozen plasma IAW local procedures and label products (A or AB) with 5 day expiration date.
2. Ensure GHC is properly charged and removed from freezer 25-30 minutes prior to loading blood products.
3. Ensure all blood products issued have a Safe-T-VUE (NSN 6515-08-T00-3056) attached and activated for temperature monitoring (Appendix E). ***Ensure thawed plasma is at refrigerated temperature (1-6°C) before placing Safe-T-VUE on unit.***
4. Evacuation personnel will follow Safe-T-VUE procedures (Appendix E) when required.
5. Document in TMDS the issuance of blood products to an evacuation team (e.g., DUSTOFF; Pararescue; Tactical Critical Care Evacuation Team).
6. Complete appropriate sections of the SF 518 *Blood or Blood Component Transfusion Record* for issuing blood products; place inside GHC pocket or attach form to each unit of blood product issued.
7. Verify the blood information on the SF 518 against the blood product label with receiving evacuation unit personnel.

Non-U.S. Issuing Facility: When U.S. blood products are to be issued from a Coalition facility, contact the Joint Blood Program Office to coordinate issuing requirements and documentation of units received.

Receiving unit (Evacuation Unit) personnel will:

1. Prior to sealing GHC, ensure each blood product loaded into the GHC has an activated Safe-T-VUE attached (Appendix E) and an SF 518 Form.
2. Accept blood products into receiving unit's TMDS inventory.
   If receiving unit is unable to access TMDS, the issuing facility will access account and receive the products under the receiving unit's TMDS inventory.

Storage, Transportation and Monitoring of Blood Products

1. All blood and blood components must be maintained in a controlled environment and stored under appropriate conditions.
2. Blood products carried outside a BSD/MTF/Lab will only be transported in an approved storage container (e.g., Golden Hour Container NSN 6530-01-505-5301; OCP/5306; Desert) for a maximum of 48 hours.
3. Units will monitor containers and document status (e.g., dry/no leaking noted) at a minimum of every 24 hours.
4. Once loaded and sealed, container will remain closed and intact at all times until blood product is required for patient care.

5. Notify the issuing facility (BSD/MTF/Lab) as soon as possible when blood products have been used.

6. GHC is only approved for 48 hours use; prior to expiration end users will contact issuing facility (BSD/MTF/LAB) to coordinate the return and exchange of a container and blood products per mission requirements.

***WARNINGS**:*
- At no time will container or its contents (blood products) be placed in a refrigerator or other cooling device outside a blood bank.
- Blood products will not be used if container is leaking; or the temperature indicator (Safe-T-VUE) on the blood product is out of standard (refer to Appendix E).
- Notify the issuing facility and return container and products for replacement.

Individual and Unit Training Requirements

1. At a minimum, medical personnel who participate in the administration of blood products during evacuation will be trained in the following topics:

    a. Indications for transfusion (Appendix C)

    b. Transfusion procedures (Appendix D);

    c. Documentation (Appendix G)

    d. PEARLS for transfusion (Appendix F)

    e. Submission of a patient safety report when required

2. At a minimum, non-medical personnel who assist will be trained in the following:

    a. Transfusion procedures

    b. Equipment/supplies

    c. Documentation requirements for the SF 518

3. Units who implement this CPG will train appropriate personnel on the following:

    a. Emergency procedures for in-flight complications.

    b. Storage container/blood product exchange requirements.

Essential Items Required for Implementing a Vampire Program

1. Approved blood component transport container.

    a. Recommend between 4 and 6 each GHCs for a Vampire Program (NSN 6530-01-505-5301 (OCP)/5306(Desert)).

b. Hemacool (NSN 4110-01-506-0895) or other freezer with temp check to ensure a temperature ≤ to (-) 18°C to support reconditioning of GHC.

2. Safe-T-VUE (NSN 6515-08-T00-3056) for temperature monitoring. (Refer to Appendix E.)

3. Establish Theater Medical Data Store (TMDS) accounts for an issuing facility (BSD/MTF (Role2/3) and LAB); and receiving unit (evacuation unit)

Warming Devices for Blood Transfusion

Use of infusion warming devices is highly recommended. These will be FDA approved for the actual use in transfusion of blood products (examples of devices include: Belmont® Buddy-lite™, EnFlow® or Thermal Angel).

***WARNING**: Warming devices will have safety mechanisms built in that prevents the output temperature from exceeding 42°C. Unit personnel will be familiar with safety mechanisms for the device used.*

Tranexamic Acid (TXA)

Patients receiving blood transfusion within three hours of injury should also receive TXA. Refer to the TCCC guidelines for administration of TXA.

Record Keeping and Documentation Requirements

1. Transfusions will be documented into TMDS by evacuation personnel, or, by issuing facility.

2. Personnel will refer to the Theater Blood Application Training Guide, 02 Jun 2014 for directions on Inventory Management-and for Transfused Products.

3. Complete SF 518 documentation and turn over at the destination MTF for placement in the patient's medical record.

References

1. Armed Services Blood Program (ASBP), Joint Blood Program Handbook, HQ Departments of the Army, Navy and Air Force (Army Technical Manual 8-227-12, NAVMED P-6530, AFH 44-152-IP), 01 Dec 2011.

2. Central Command Regulation (CCR) 40-1, Quality Management (QM) Programs in Healthcare Operations, 19 Feb 2016.

3. CCR 40-4, Clinical Operations (CLINOPS) Program, Jan 2016.

APPENDIX C: CLINICAL INDICATIONS OF HEMORRHAGIC SHOCK

Clinical Evidence Hemorrhagic Shock Is Present		
H	Hypotension	Systolic blood pressure <100mmHg
T	Tachycardia	>100 BPM; Unresponsive to a 250-5000cc fluid bolus (NS/LR)
R	Respirations	Rapid/shallow
P	Pulse (poor character)	Weak and thready (ineffective)
M	Mental status	Decreased (excluding head injury)
S	Skin color	Pale/cyanotic
C	Continued bleeding	From non-compressible wound

APPENDIX D: TRANSFUSION PROCEDURES

TRANSFUSION PROCEDURES

MAINTAIN UNIVERSAL PRECAUTIONS (Gloves & Eye Protection)

STEP 1: ESSENTIAL BLOOD ADMINISTRATION ITEMS

1. "Y" Type Filtered Blood Administration Set (**UNDER NO** circumstances should non-filtered tubing be used)
2. Blood Product to Transfuse (**Universal Donor is approved for Prehospital**)
3. 0.9% NS (**Dedicated Line Only for Blood Products**)
4. Blood Pressure Cuff/Monitor
5. Blood Warmer Device
6. Pressure bag (if available)

STEP 2: PRE-TRANSFUSION TASK

Two Person Verification Process

Verify Blood Label. Complete SF 518 for 5 items below or transcribe items from Blood Label onto blank SF 518: (1) Unit#; (2) Type of Product; (3) Donor ABO/Rh (**Must be O for RBCs; and A or AB for Plasma**); (4) Expiration Date; and (5) Temperature Indicator (RED = NOT ACCEPTABLE)

1. CLOSE all 3 clamps on Y tubing
2. NOTE: When using blood/fluid warming device, attach line to fluid warmer cartridge and fluid warmer extension line.
   a. Ensure warming device is functioning IAW manufacturers guidelines
3. Insert 1st spike into NS bag and hang; OPEN clamp and prime only the "Y" section; CLOSE clamp
4. Insert 2nd spike into blood product and hang; OPEN clamp and run the length of the tubing
5. Attach line to IV or IO site ****Ensure good flow through IV/ IO before initiating transfusion****
6. Ensure all clamps are CLOSED
7. Note/document pre-transfusion vitals - at a minimum BP and HR
8. **Medical person will visually inspect blood product, if possible, for gas, discoloration, clots, foreign objects, or, sediment, and ensure no cracking of the plastic bag that has led to leaking.**
   a. **Visually inspect the Temperature Indicator** (RED = NOT ACCEPTABLE)
9. Non-Medical person can assist with documentation on the SF 518 for Pre and Post transfusion in formation

STEP 3: TRANSFUSION TASK

1. OPEN main line clamp for blood product to begin infusion.
   a. **ENSURE CLAMP to NS REMAINS CLOSED.**
   b. **UNDER NO CIRCUMSTANCES** will other medications or IV fluid (including 3%NS) be introduced through transfusion line. This will cause hemolysis/clotting of blood products.
2. **Blood products must be transfused within 4 hours of removal from a storage container** - if not, the product(s) will be returned to issuing facility or delivered with patient to MTF to be discarded.
3. If using pressure infuser set pressure to 300 mmHg.
4. Monitor vitals IAW TCCC Guidelines.
5. When blood product has been infused, CLAMP blood product line and OPEN NS line to deliver residual blood product.
6. If 2nd Unit required - CLOSE NS clamp.
7. Spike 2nd Unit - OPEN blood product and main line clamps to begin 2nd infusion.
8. Monitor closely and continue VS assessment.
9. VS goal: SBP >l00mmHg; and/or Pulse <100; MAP 70-80 mmHg

STEP 4: DOCUMENTATION TASK

1. **Pre-transfusion Data**
   a. Unit Number
   b. Type of Blood Product (RBC/ Plasma)
   c. Donor ABO/Rh
   d. Expiration Date
   e. Vital Signs (HR and B/P)
2. **Post Transfusion Data**
   a. Vital Signs
   b. Date/Time started/completed
   c. Note if interrupted and reason for interruption
   d. Patient Identification (as much as possible)

APPENDIX E: SAFE-T-VUE TEMPERATURE INDICATOR

SAFE-T-VUE TEMPERATURE INDICATOR

ISSUING FACILITY INSTRUCTIONS

1. Safe-T-VUE® 10 is a temperature sensitive indicator that easily adheres directly to blood bags during transport and changes color from WHITE to RED when the 10°C indication temperature has been reached or exceeded.
   a. Safe-T-VUE is non-reversible and indicates that a high temperature condition existed, even if temperature returns to a lower level. As long as indicator remains WHITE, blood may be stored for future use.
2. Prepare the Safe-T-VUE temperature indicator by refrigerating for a minimum of 24 hours at 1-6°C.
3. Remove the blood product and one Safe-T-VUE indicator from the refrigerator at the same time and place on a clean dry surface.

NOTE: Remove excess moisture from the blood product bag by using a dry wipe/paper towel on the surface where the Safe-T-VUE is to be applied.

NOTE: Use of cold pack on the surface below the blood product will help to maintain temperature

4. Hold Safe-T-VUE against the blood product with fingertips. Peel off the "REMOVE" label to expose the adhesive.

NOTE: Be careful to only handle around the edge of the indicator to expose RED DOT and WHITE DOT.

5. Attach Safe-T-VUE directly to the lower third of the blood product bag where there is a large volume of product.

CAUTION: Ensure thawed plasma is at refrigerated temperature (1-6°C) before placing Safe-T-VUE on unit.

NOTE: Be certain the Safe-T-VUE indicator is in complete contact with the blood component bag being monitored. No air pockets should be under the indicator (e.g., fold in the bag; over any labels; or any other obstruction).

6. Fold WHITE DOT onto the RED DOT and press firmly together to activate.

CAUTION: Be careful to ONLY press on the GREEN color-coded end to activate properly.

CAUTION: It is important to place pressure on the outer edge of the WHITE DOT, and not the center, when pressing onto the RED DOT to prevent false activation.

7. Issuing facility will complete documentation on SF 518 for each blood product unit, place inside GHC pocket and secure container.
8. Receiving personnel will understand color change temperature indication:
   a. When WHITE DOT turns solid RED, temperature has reached ≥10°C
      - Return blood product to issuing facility (BSD/MTF/LAB)
   b. Appearance of SMALL RED DOTS is an indication blood product requires cooling or immediate refrigeration.
      - Return product to issuing facility (BSD/MTF/LAB) for appropriate cooling/refrigeration
   c. WHITE DOT –product is acceptable for transfusion

APPENDIX F: PEARLS FOR TRANSFUSIONS

PEARLS FOR TRANSFUSIONS

PRE-TRANSFUSION PEARLS

1. Use of 2% Lidocaine (2-3ml) with 0.9% NS is permitted to flush any IO site prior to blood product transfusion.
2. Consider pain control measures to reduce tachycardia resulting from uncontrolled pain.
3. Once removed from storage container blood products will be transfused in under 4 hours
4. ONLY USE "Y" filtered blood administration sets
5. If directly involved in patient care, 1st Verifier (Medical Person) can direct a non-medical person to be the 2nd Verifier and record data on the SF518
6. **DO NOT** use blood product if storage container is leaking or temperature indicator is **RED**
7. **If using enFLow® fluid warmer – add IV extension tubing
8. DO NOT allow blood warmer to be placed directly on patient's skin as this may cause burning
9. If Thawed plasma is available, it should be given prior to RBC; normal ratio is 1:1

DURING TRANSFUSION PEARLS

1. Transfusion infusion rates can be titrated to slower rates if VS parameters move to appropriate levels (SBP>100; HR<100; MAP 70-80).
2. Special attention should be paid to non-compressible injuries (chest; abdominal; and pelvis) so as to NOT raise the SBP over 90mmHg.
3. Once transfusion is initiated, decrease all other fluids to KVO rate.
4. **In-flight emergencies:**
   a. Contact unit FS or tactical operation center for medical direction; or
   b. **Divert to nearest MTF (Do not delay divert waiting on medical direction)**
5. If transfusion is interrupted, record date/time and reason for interruption on SF518 if not able to resume within 5 min
6. Under **NO CIRCUMSTANCES** will other medications or IV fluids (to include 3% NS) be introduced through transfusion line.
7. Blood output temperature from a warmer device **WILL NOT EXCEED** 42°C (107°F)

DURING TRANSFUSION PEARLS

1. Suspected /confirmed transfusion reaction: STOP TRANSFUSION
2. **Disconnect tubing from infusion site; flush IV site with NS**
3. Keep IV Line OPEN with NS
4. Re-initiate transfusion only if it is deemed clinically essential
5. Document on SF 518 date/time and actions taken

POST TRANSFUSION PEARLS

1. After 1st transfusion, re-evaluate casualty and initiate 2nd unit ONLY if criteria is still met (Appendix A)
2. If 1st unit is initiated based on "Stand-Alone" injury (Double/Triple/Quadruple Amputation); subsequent units will be based on VS parameters
3. Complete documentation on SF518
4. Consider Tranexamic Acid (TXA) – follow TCCC Guidelines for Administration

PATIENT HAND-OFF (COMMUNICATION)

1. Provide receiving MTF with completed SF 518s for patients record
2. Report any adverse events; transfusion reactions ; and actions taken en route
3. Report interrupted transfusions and provide explanation
4. Report O POS blood given to female patients between the age of 10-50

APPENDIX G: REQUIRED DOCUMENTATION FOR TRANSFUSION

- SF 518 Blood or Blood Component Transfusion Record ASBP
- 151 Whole Blood Transfusion Checklist
- 147 Eldon Card ABO/Rh Typing Record
- 145 Infectious Disease Testing for Blood Donation
- 148 Pre-screen Whole Blood Sample Shipping Manifest
- 150A Emergency Release Letter of Understanding (tested)
- 150B Emergency Release Letter of Understanding (untested)
- 572 Emergency Whole Blood Donation Record
- AABB Medications Deferral List
- DHQ Medication Deferral List

APPENDIX H: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

The Prevention of Deep Venous Thrombosis – Inferior Vena Cava Filter (CPG ID: 36)

To establish guidance for 1) anti-thrombotic therapy for the prevention of deep venous thrombosis (DVT) and pulmonary embolism (PE) and 2) the management of inferior vena cava filters (IVCs) placed in the combat theater for the purpose of either primary or secondary prophylaxis of pulmonary embolism.

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BACKGROUND

Trauma patients are known to be at high risk for Venous Thromboembolism (VTE) including Deep Venous Thrombosis (DVT) and Pulmonary Embolism (PE). Major trauma patients can have up to 58% incidence of DVT.[1] Sevitt and Gallagher reported an even higher incidence (65%) in injured and burned patients and reported a 16.5% incidence of PE found at autopsy in this cohort of patients.[2,3]

In addition to the hypercoagulable state induced by severe injury in trauma, combat casualties have additional risk factors for DVT, including:[1,4-8]

- Early transfusion of blood products (≤24 hours);
- Transfusion of old blood (≥28 days);
- Multiple and/or above the knee amputations

The use of Fresh Frozen Plasma (FFP) outside of large volume blood product transfusion (less than 4 U PRBC's) incurs an increased risk of VTE.[9] Early prophylaxis in this patient population is recommended provided hemostasis has been achieved.

The nature of the current combat theater has provided our deployed medical team's ample opportunity to care for children injured as non-combatants. The incidence of DVT after trauma is much lower (6.2%) than that of adults in the civilian literature.[10] The presence of multiple risk factors including immobility and central venous line, however, were associated with the development of DVT in pediatric trauma patients.

There is an increasing recognition of DVT in individuals who complete an extended period of travel on an airplane. One study noted a 10% prevalence of asymptomatic DVT in individuals undergoing flights of 8 hours or more.[11] Combat casualties are at high risk for VTE during recovery and evacuation, which can be associated with long flights and immobility, thus it is important to start VTE prophylaxis as soon as clinically possible.[12]

Landstuhl Regional Medical Center is uniquely positioned to receive patients who have undergone extensive periods of travel prior to admission.

Different medical societies and working groups have published varying recommendations for DVT prophylaxis.[13,14] The clinical guidance recommended here represent the guidelines with either a higher level of scientific evidence supporting the recommendation, or the more conservative recommendation. It is recommended to begin DVT prophylaxis therapy as soon as coagulopathy is corrected in patients not otherwise at increased risk of bleeding.

RECOMMENDATIONS FOR DVT PROPHYLAXIS

Unless contraindicated by lower extremity injury, all trauma patients should receive:

1. Sequential Compression Device (SCD) therapy as primary DVT prophylaxis in addition to;
2. Low dose Unfractionated Heparin (UFH)[13-15]; or
3. Low Molecular Weight Heparin (LMWH), Enoxaparin 30mg subcutaneous (SC) twice daily.[16]
4. Alternatively, low does LMWH such as Dalteparin 5000 U SC or Enoxaparin 40mg SC can be given daily and in one study has a lower incidence of DVT when compared to 30mg BID dosing in post-operative patients.[14,17,18]

5. Unfractionated Heparin (5000 U) administered subcutaneously three times daily has been demonstrated to be as effective as or at least non-inferior to Enoxaparin in the prevention of DVT in trauma patients.[19,20]

Consideration should be given to the use of LMWH in patients with impaired renal function (CrCL=30ml/min or less), as there is a concern for LMWH accumulation and increased risk of bleeding.

1. Despite this concern, no clear evidence exists for dose modification or contraindication to the use of LMWH for DVT prophylaxis in renal impaired patients.[21]

2. Godat et al. reported, however, that trauma patients who are considered to be at the highest risk to develop VTE (especially spinal cord injury with/without pelvic fracture) are at the greatest risk during the first three months after injury and that this risk decreases at six months post injury.[23]

The role of **duplex ultrasound** in the diagnosis of DVT should be reserved for the symptomatic patient. Serial screening duplex ultrasound for the diagnosis of DVT is not recommended.[14]

CHEMICAL DVT PROPHYLAXIS

Provided coagulopathy and ongoing bleeding is corrected, chemical DVT prophylaxis (<48 hours post injury) has been shown to be safe after blunt solid organ injuries.[24,25]

Chemical DVT prophylaxis (<48-72 hours) following traumatic brain injury with intracranial hemorrhage does not increase the progression of intracranial bleed.[26,27] Prior to starting chemical DVT prophylaxis, you should:

1. Consult a Neurosurgeon.

2. Obtain a stable CT scan of the head at 24 hours post injury.

Prophylaxis should be withheld in the setting of progression of intracranial hemorrhage or presence of an intracranial monitor.

Modification of enoxaparin dosing to 40mg daily in the combat casualty requiring an epidural pain catheter does not increase the incidence of venous thromboembolism.[28]

Inferior Vena Cava Filter (IVCF) placement in the combat theater may be used for:

1. Primary Prophylaxis (no evidence of VTE disease at the time of placement).

2. Secondary Prophylaxis (documented DVT) of PE in the polytrauma patient.

Patients felt to be at particularly **high risk for VTE development** and who have a clinical contraindication to prophylactic anticoagulation are the most likely to have an IVCF placed.

Most series examining the use of **IVCF placement for primary prophylaxis of PE** in the trauma patient support a low rate of subsequent PE (1.6%), although the studies are of variable design and a strong consensus supporting this clinical practice cannot be made based upon available data.[29]

There is no evidence that **prophylactic use of IVCF** is associated with a decreased PE rate or fatal PE rate. It should be noted that when IVCF are placed they are done so to prevent FATAL Pulmonary Emboli as DVT and PE still can occur.[30-34]

IVCF has no benefit in the prevention of DVTs and may be associated with the development of IVC and Deep Venous Thrombosis.[14,35]

RETRIEVABLE INFERIOR VENA CAVA FILTERS (RIVCF)

The vast majority of IVCF devices placed in the combat theater are Retrievable Inferior Vena Cava Filters (RIVCF).

RIVCF are preferred to avoid some of the long-term complications of filter placement. Additionally, many patients only need this form of VTE prophylaxis for a defined period of time early after injury.

Despite successful removal of IVCF beyond 180 days and high success and low complication rate for attempted **IVCF removal**, rates of eventual removal of RIVCFs in multiple studies of trauma patients in the United States have been as low as 14% to 22%.[36,37,38,39,40]

Combat injured patients from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) who had RIVCFs placed have an overall retrieval rate of 18%.[41]

It should be noted however; that the majority of patients was lost to follow up or did not have filters removed due to ongoing indications for use (82%). Therefore, the overall retrieval technical success rate may be much higher. Most series support removal of the most commonly used RIVCFs as early as they are no longer necessary and no later than approximately three months.[42] While it is possible to remove any of these later than this time period, the technical success declines significantly as potential complications associated with removal increase. Clear electronic documentation and a dedicated tracking system at the final CONUS MTF must be in place to improve retrieval rates and minimize loss to follow up.[43]

EDUCATION AND TREATMENT

Refer to Appendix A for specific guidance on different subsets of patients after various surgical procedures.

Refer to Appendix B for additional recommendations regarding IVC filters.

AEROMEDICAL EVACUATION CONSIDERATIONS

1. Aeromedical Evacuation (AE) from any area of responsibility to continental U.S. can require multiple flights over the course of days before the patient arrives at his or her final destination.
2. There is a clear association between long-distance travel and an increased risk of VTE, even in a "healthy traveler."
    3. Stresses of flight such as prolonged immobility and decreased humidity may contribute to VTE formation, especially in groups who already carry a high risk (trauma patients, recent surgeries, long bone fractures, smokers, pregnancy or post-partum, recent Myocardial Infarction, active cancer, presence of splint or cast, etc.).
4. Prophylaxis is essential to reduce the risk of VTE associated morbidity and mortality in all AE patients.
    a. AE crews will encourage patient ambulation every 2 hours for patients whose condition allows.
    b. SCD use should be universal for inpatients unless contraindicated by injury pattern. The Kendal SCD Express compression system is approved for use on military aircraft.
    c. Chemical VTE prophylaxis is also recommended as above for all trauma or medical inpatients unless specifically contraindicated by the medical condition such as ongoing bleeding or coagulopathy.
5. AE Patients with KNOWN acute VTE should be treated prior to flight unless there is a clear contraindication.
    a. Treatment depends on the clinical situation, but may include low-molecular-weight Heparin, Fondaparinux, oral Xa inhibitors, or Unfractionated Heparin.
    b. Oxygen and continuous pulse-oxygenation monitoring should be available during AE for patients with known VTE in case supportive measures are needed.

c. In the case of known or suspected Pulmonary Embolism, a Cabin Altitude Restriction should be considered to mitigate the effects of altitude on oxygenation and respiration.
d. Addition of a Critical Care Air Transport Team should also be considered in cases of PE with significant respiratory or hemodynamic compromise.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All trauma patients admitted to Role 2 or higher.

INTENT (EXPECTED OUTCOMES)

1. All patients in population of interest receive DVT prophylaxis with sequential compression device within 24 hours of injury.

2. All patients in population of interest start chemoprophylaxis (Heparin, Lovenox) within 48 hours of injury or contraindication documented.

3. When IVCF is inserted, there is documentation in the medical record regarding the indication for procedure, whether the IVCF is retrievable, manufacturer, brand, serial number, lot number, and exact location of placement.

4. Retrievable IVC filters are removed within 6 months.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who start DVT prophylaxis with sequential compression device within 24 hours of injury.

2. Number and percentage of patients in the population of interest who receive DVT chemoprophylaxis within 48 hours (Heparin, Lovenox) or have contraindication documented.

3. Number and percentage of patients who receive IVC filter placement who have complete documentation of indication for procedure, whether the IVCF is retrievable, manufacturer, brand, serial number, lot number, and exact location of placement.

4. Number and percentage of retrievable IVC filters placed that are removed within 6 months.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the Joint JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

All Health Care Providers will:

- Become familiar with the guidelines for the prevention of DVT (see Appendix A).
- Appropriately manage patients who may be at risk of developing DVT.
- Provide feedback on these guidelines and suggestions for changes to the CPG to the JTS Chief.

The senior surgeon and/or Intensivist at each Role 3 facility will:

- Review all thromboembolic events in the Level III facility to assess ways to reduce the risk to the patient.
- Coordinate with the JTS Performance Improvement Division Chief on the appropriateness of the guidelines being used and provide input for updates on an as needed basis.

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APPENDIX A: PREVENTION OF VENOUS THROMBOEMBOLISM GUIDELINES

RISK GROUP	PROPHYLACTIC MEASURES
TRAUMA PATIENTS	
▪ Emergency trauma surgical procedures in patients with prohibitive risk of bleeding, or ongoing coagulopathy	▪ SCD (sequential compression device) until able to be anticoagulated (ideally start Lovenox within 12 hours of cessation of coagulopathy); see IVC filter and Duplex screening sections below.
▪ Emergency trauma surgical procedures in all patients, except patient with prohibitive risk of bleeding (once coagulopathy not present)	▪ SCD (unless contraindicated by injury) + Lovenox 30 mg SC BID or 40mg SC QD; alternatively Heparin 5000 U SC q 8 hours
▪ Isolated major orthopedic surgery of extremities, spine, and pelvis	▪ SCD (unless contraindicated by injury) + Lovenox 30 mg SC BID
IVC FILTER PLACEMENT	
Patients with: 1. Recurrent PE despite full anticoagulation 2. Proximal DVT and contraindications for full anticoagulation 3. Proximal DVT and major bleeding while on full anticoagulation 4. Progression of iliofemoral clot despite anticoagulation Patients with established DVT or PE and: 5. Large free-floating thrombus in the iliac vein or IVC 6. Following massive PE in which recurrent emboli may prove fatal 7. During/after surgical embolectomy Very High Risk Patients: those who cannot receive anticoagulation because of increased bleeding risk and : 8. Severe closed head injury (GCS<8) 9. Incomplete spinal cord injury with paraplegia or quadriplegia 10. Complex pelvic fractures with associated long-bone fractures 11. Multiple long-bone fractures	▪ Placement of retrievable IVC filter (RIVCF) ▪ **Document if the IVCF is retrievable or not, manufacturer, brand, MRI compatibility, serial number, lot number and exact location** in record and TMDS; PE may still occur despite IVC filter ▪ "Extended" indications for placement of IVC filter for patients with established DVT or PE ▪ Consideration of placement of prophylactic placement of IVC filter.
ROLE OF DUPLEX SCREENING	
▪ Asymptomatic patients	▪ Serial duplex ultrasound imaging of high-risk patients is not recommended.
▪ Symptomatic patients	▪ Duplex ultrasound may be used without confirmatory venography.
GENERAL, VASCULAR, UROLOGIC SURGERY	
LOW RISK:	
Minor procedure in patients < 40 years, no risk factors	Early mobilization
MODERATE RISK:	
▪ Minor procedure with additional risk factors for thrombosis; ▪ Non major surgery in patients 40-60 years, with no additional risk factors; ▪ Major surgery in patients < 40 years with no additional risk factors)	▪ SCD + Unfractionated Heparin 5000 units SCq 8 hours or Lovenox 40 mg SC QD ▪ Chemical DVT prophylaxis is withheld in patients with high risk of bleeding.

RISK GROUP	PROPHYLACTIC MEASURES
HIGH RISK:	
▪ Non major surgery in patients > 60 years or have additional risk factors; ▪ Major surgery in patients > 40 years or have additional risk factors	▪ SCD + Unfractionated Heparin 5000 units SC q 8 hours or Lovenox 40 mg SC QD ▪ Chemical DVT prophylaxis is withheld in patients with high risk of bleeding.
NEUROSURGERY	
▪ Intracranial neurosurgical procedures ▪ High Risk neurosurgery patients	▪ SCD ▪ SCD ▪ Chemical DVT prophylaxis following stable CT scan in consultation with neurosurgeon

APPENDIX B: IVCF RECOMMENDATIONS

1. All IVCFs placed in the combat theater should be retrievable.
2. Documentation detailing the ICVF brand, model, MRI compatibility, and exact location of placement should be documented in ALTHA T or TC2.
3. All RIVCFs placed in the combat theater should be removed as soon as contraindications to chemical prophylaxis of VTE disease no longer exist or there is no longer a need for VTE prophylaxis. Exceptions include those that were placed for secondary prophylaxis in a patient who demonstrated new VTE disease while on therapeutic anticoagulation or in patients who are still deemed to be high risk.
4. All RIVCFs should be removed within three months unless a long term indication for their continued use is present.
5. The decision to remove an RIVCF placed in the combat theater (versus leaving it in place permanently) should be made at the first CONUS Level V MTF the patient transitions through while returning from deployment. When possible, the removal should take place at this same facility prior to transition to the next level of care. This approach decreases the chance that a decision will be deferred until removal becomes technically prohibitive.
6. **The presence of a RIVCF in a patient receiving care at the Level IV MTF should be made known to the receiving Level V MTF. Typically, retrieval of the RIVCF will be accomplished at the Level V MTF.**
7. Any patient with a known DVT and without a current contraindication to therapeutic anticoagulation who has an IVCF in place should receive full dose anticoagulation. This is preferably accomplished with Coumadin to target an INR of 2.0-3.0. If further surgical procedures are planned, consideration may also be given to the use of low molecular weight heparin dosed at 1 mg/kg bid or an unfractionated heparin drip until such time as the use of Coumadin is felt to be appropriate.
8. The presence of an IVCF, brand, model, MRI compatibility, whether or not it is retrievable, its exact location and the date of insertion should be clearly annotated in TMDS and again in AHLTA when the patient has returned to the United States.
9. Efforts should be made in the future to standardize the type of RIVCF used at all combat theater locations.

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

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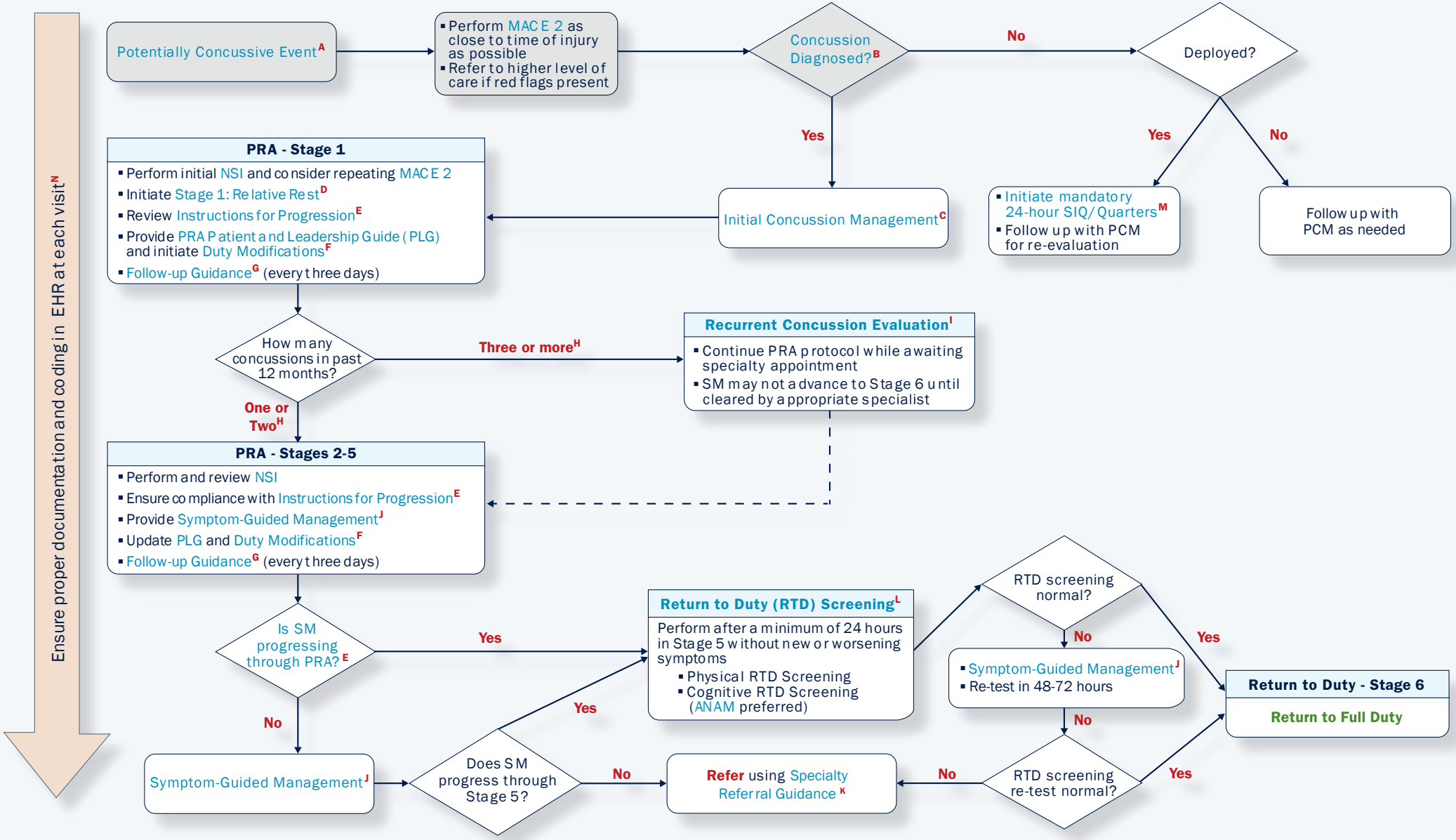
Progressive Return to Activity Following Acute Concussion/Mild Traumatic Brain Injury

The algorithm below provides guidance on how to return a service member to full duty following a concussion. This is an interactive document. Please click the appropriate links in each box for detailed instructions and additional resources. To navigate back to this page use the 'Return to Algorithm' button at the bottom of each page.


Ensure proper documentation and coding in EHR at each visit[N]
Potentially Concussive Event[A]
Perform MACE 2 as close to time of injury as possible
Refer to higher level of care if red flags present
Concussion Diagnosed?[B]
No
Deployed?
Yes
No
Yes
Initial Concussion Management[C]
PRA - Stage 1
Perform initial NSI and consider repeating MACE 2
Initiate Stage 1: Relative Rest[D]
Review Instructions for Progression[E]
Provide PRA Patient and Leadership Guide (PLG) and initiate Duty Modifications[F]
Follow-up Guidance[G] (every three days)
Initiate mandatory 24-hour SIQ/Quarters[M]
Follow up with PCM for re-evaluation
Follow up with PCM as needed
How many concussions in past 12 months?
Three or more[H]
Recurrent Concussion Evaluation[I]
Continue PRA protocol while awaiting specialty appointment
SM may not advance to Stage 6 until cleared by appropriate specialist
One or Two[H]
PRA - Stages 2-5
Perform and review NSI
Ensure compliance with Instructions for Progression[E]
Provide Symptom-Guided Management[J]
Update PLG and Duty Modifications[F]
Follow-up Guidance[G] (every three days)
Is SM progressing through PRA?[E]
Yes
Return to Duty (RTD) Screening[L]
Perform after a minimum of 24 hours in Stage 5 without new or worsening symptoms
Physical RTD Screening
Cognitive RTD Screening (ANAM preferred)
RTD screening normal?
No
Yes
Symptom-Guided Management[J]
Re-test in 48-72 hours
Return to Duty - Stage 6
Return to Full Duty
No
RTD screening re-test normal?
No
Yes
No
Refer using Specialty Referral Guidance[K]
Does SM progress through Stage 5?
Yes
No
Symptom-Guided Management[J]

A. Potentially Concussive Event: Per DoDI 6490.11, events requiring mandatory rest periods and medical evaluations and reporting of exposure of all involved personnel include, but are not limited to:

- Involvement in a vehicle blast event, collision, or rollover
- Presence within 50 meters of a blast (inside or outside)
- A direct blow to the head or witnessed loss of consciousness
- Exposure to more than one blast event (the service member's commander shall direct a medical evaluation)

B. Concussion Diagnosis: 2015 DoD Definition of Traumatic Brain Injury: A traumatically induced structural injury or physiological disruption of brain function, as a result of an external force, that is indicated by new onset or worsening of at least one of the following clinical signs immediately following the event:

- Any alteration of mental status (e.g. confusion, disorientation, slowed thinking, etc.)
- Any period of loss of or a decreased level of consciousness, observed or self-reported
- Any loss of memory for events immediately before or after the injury

TBI Severity			
Criteria	**Mild/Concussion**	**Moderate**	**Severe**
Structural imaging	A CT scan is not indicated for most patients with a concussion*	Normal or abnormal	Normal or abnormal
Loss of consciousness (LOC)	0–30 minutes	>30 minutes and <24 hours	>24 hours
Alteration of consciousness (AOC)	up to 24 hours	>24 hours. Severity based on other criteria	
Post-traumatic amnesia (PTA)	0–1 day	>1 and <7 days	>7 days

* If obtained, the CT scan is normal

C. Initial Concussion Management: May be performed by first responder/medic/corpsman, emergency department provider, or PCM

- Provide concussion education and set expectations for full recovery
  - What You Should Know About Concussions
  - Healthy Sleep Following Concussion/mTBI
- Manage acute headache
  - Use acetaminophen every 6 hours for 48 hours followed by NSAIDs as needed
  - Delay use of NSAIDs for 48 hours after concussion
  - Avoid tramadol, acetaminophen/caffeine/butalbital, and opioids
  - Refer to Headache Following mTBI Clinical Recommendation for further guidance
- Review current medications and supplements
- Initiate 24-hour SIQ/Quarters
- Follow up with PCM in 24 hours

D. Relative Rest: Physical and cognitive activities that do not provoke symptoms

- Light physical activities
- Simple, familiar cognitive tasks
- Quiet environment with limited stimulation
- Healthy sleep and nutrition

Note: Stage 1 of the PRA consists of full-time relative rest. In Stages 2–5, service members should continue to utilize these guidelines to rest between more strenuous activities or if they exhibit any new or worsening symptoms.

E. Stages of the PRA: Instructions for Progression (Continued on next page)

Stage	Objective	Environment	Physical/Vestibular Activity	Cognitive/Oculomotor Activity	Restrictions Stages 1-5
Stage 1*: Relative Rest	Avoid symptom provocation, and rest to promote recovery	▪ Minimize light and noise ▪ Stay home/in quarters	▪ Daily activities that do not provoke symptoms ▪ Limit large or sudden changes in head position ▪ No exercise	▪ Limit screen time as needed to avoid symptom provocation ▪ Very light leisure activity (e.g. reading, television, conversation)	▪ Do not go outside the wire in a combat zone ▪ Maintain or reduce pre-injury levels of caffeine/energy drinks and nicotine ▪ No alcohol** ▪ No combatives or contact sports*** ▪ No driving until visual and vestibular symptoms have resolved ▪ No weapons fire or blast exposure***
Stage 2: Symptom-Limited Activity	Introduce and promote mild exertion	▪ Calm and familiar environment with limited distractions	▪ Limit large or sudden changes in head position ▪ Light routine exertion (e.g. walking on even terrain, light household chores, stationary bike) ▪ No weight or resistance training	▪ Simple, familiar activities performed one at-a-time (e.g. routine computer use, leisure reading)	
Stage 3: Light Activity	Introduce occupation-specific exertion and environmental distractions	▪ Introduce environmental distractions during activity ▪ Return to work on limited duty/profile without significant symptom provocation	▪ Initiate tasks requiring changes in head position ▪ Light aerobic exercise without resistance (e.g. elliptical, stationary bike, walking on uneven terrain) ▪ No lifting > 20 pounds ▪ No resistance training	▪ Simple, unfamiliar tasks or complex familiar tasks (e.g. grocery shopping, technical reading)	
Stage 4: Moderate Activity	Increase activity intensity and duration	▪ Distracting or busy environment during activity as tolerated	▪ Attempt tasks requiring more significant or sudden changes in head position ▪ Increase intensity and duration of activities (e.g. non-contact sports, hiking or running, push-ups, sit-ups) ▪ Introduce resistance training as tolerated	▪ Increase intensity and duration of activities (e.g. navigate busy environments, recall and follow complex instructions)	
Stage 5*: Intensive Activity**	Introduce exertion of duration and intensity that parallels service member's typical role ▪ Complete RTD Screening prior to advancement to Stage 6	▪ Typical daily environment EXCEPT listed restrictions	▪ Resume pre-injury exercise routine and training activities	▪ Complex problem solving or multi-tasking with exertion or distracting environment	
Stage 6: Return to Full Duty	Return to pre-injury activities	▪ Typical daily environment	▪ Unrestricted activity		

* Ensure SM adheres to Relative Rest guidelines and attempts to increase activity within 72 hours to avoid potentially detrimental effects of prolonged rest

** Alcohol use can exacerbate post-concussive symptoms of headache, depression, and anxiety and can cause impaired cognitive functioning, dehydration, and sleep disturbances

*** In Stage 5 the SM may gradually increase exposure to high risk activities in a *supervised* training environment based on mission requirements

E. Instructions for Progression:

- Review Stages of the PRA
- SM must spend at *least* 24 hours in each stage
- At the beginning of each day the SM should self-evaluate their symptoms
  - If symptoms are the **same as or better** than the previous day AND there are no **new** symptoms, advance to the next stage
  - If symptoms are **worse** OR there are **new symptoms**, remain in current stage for an additional 24 hours
  - For patients that are not improving or worsening, reference Follow-up Guidance, Symptom-Guided Management, or Specialty Referral Guidance
- If symptoms worsen during an activity, the SM should follow the guidelines for Relative Rest until the exacerbation resolves, and then return to the previously tolerated stage for the remainder of the day
- After 24 hours in Stage 5 without new or worsening symptoms, the SM should follow up with PCM for Return to Duty Screening

F. Duty Modifications:

- The Patient and Leadership Guide (PLG) provides answers to common questions that command leadership may have regarding the PRA process and duty modifications. In addition, it outlines activities that the SM should and should not perform for each stage of the PRA.
- Ensure that the PLG is given to every SM with a concussion and communicated with their chain of command.
- Policies and procedures are service and command specific. Consult duty and deployment standards for your organization when dispositioning patient.
- Specific restrictions based on the patient's MOS/NEC/AFSC, individual injury characteristics, or any other factors should be annotated on the chit/profile as well as any reasons for lack of adherence to uniform standards.

G. Follow-up Guidance:

- Schedule follow-up appointments every 3 days or sooner if symptoms acutely worsen
  - Consider virtual, telephone, or clinical support staff follow-ups if feasible in your practice setting
- If service member does not advance through a single stage for 3 consecutive days, upon follow-up:
  - Ensure compliance with activity recommendations
  - Refer to Symptom-Guided Management
- If symptoms persist >15 days, consult Specialty Referral Guidance

H. Multiple Concussion Guidance: Required for deployed SMs per DoDI 6490.11, and recommended for SMs in garrison

- **Two concussions in the last 12 months**:
  - SM must spend a minimum of 7 days in the PRA protocol prior to RTD Screening
- **Three or more concussions in the last 12 months**:
  - Refer for Recurrent Concussion Evaluation
  - Continue PRA protocol while awaiting specialty appointment
  - SM can only be returned to full duty (Stage 6) by a specialist
- For imaging recommendations refer to the Neuroimaging Following Mild TBI Clinical Recommendation

I. Recurrent Concussion Evaluation: Required for SMs who have sustained 3 or more concussions in a 12-month span

J. Symptom-Guided Management:

- The following table provides recommendations and resources for how to treat the most common symptoms associated with concussion.

Symptom Cluster	Signs and Symptoms	Evaluation	Primary Care Management
Anxiety/ Mood	▪ Depression/feeling sad ▪ Irritability ▪ Low tolerance to frustration ▪ Mood changes/lability ▪ Nightmares	▪ GAD-7 ≥10 ▪ NSI questions 17–22 ▪ PHQ-9 ≥10	▪ Refer immediately to Behavioral Health for any concerns about harm to self or others ▪ Consider acute intervention in cases of acute stress reaction: education, reassurance of safety, normalization, acute symptom management, social support ▪ Non-pharmacologic: mindfulness, deep breathing and relaxation, pleasurable activities, exercise (if appropriate) ▪ Depression Resources ▪ Primary Care Behavioral Health Clinical Pathways ▪ VA/DoD PTSD and ASD CPG
Cervical	▪ Dizziness (cervicogenic) ▪ Headache ▪ Neck pain ▪ Numbness	▪ Physical exam	▪ Non-pharmacologic: Traditional Chinese or Medical Acupuncture ▪ Pharmacologic: acetaminophen every 6 hours for up to 48 hours post-concussion followed by NSAIDs as needed; avoid tramadol, acetaminophen/caffeine/butalbital, and opioids ▪ Dizziness Following mTBI Clinical Recommendation ▪ Headache Following mTBI Clinical Recommendation
Cognitive	▪ Confusion/foggy thinking ▪ Delayed response ▪ Difficulty concentrating ▪ Difficulty with memory/forgetfulness	▪ MACE 2 cognitive score <25 ▪ NSI questions 13–16	▪ If there are any concerns about cognition, confirm patient report of symptoms and performance with third party when possible ▪ Physical and sleep-related symptoms may impact cognitive function- identify and treat contributing conditions ▪ Cognitive Rehabilitation Following mTBI Clinical Recommendation
Headache	▪ Auras ▪ Neck pain ▪ Numbness, tingling, weakness ▪ Phonosensitivity ▪ Photosensitivity	▪ HIT-6 ≥50 ▪ NSI questions 4–7, 9, 11	▪ Non-pharmacologic: Traditional Chinese or Medical Acupuncture ▪ Pharmacologic: acetaminophen every 6 hours for up to 48 hours post-concussion followed by NSAIDs as needed; avoid tramadol, acetaminophen/caffeine/butalbital, and opioids ▪ Headache Following mTBI Clinical Recommendation
Oculomotor	▪ Blurry vision ▪ Decreased attention for visual tasks ▪ Difficulty reading (paper or screen) ▪ Double vision ▪ Eye strain ▪ Headache ▪ Photosensitivity	▪ NSI questions 4, 6, 7 ▪ VOMS Abnormal Smooth Pursuits, Saccades, or Convergence testing	▪ Oculomotor symptoms often spontaneously resolve within a few weeks after injury ▪ Visual Dysfunction Following mTBI Clinical Recommendation ▪ VOMS Visual Guide
Sleep	▪ Difficulty falling/staying asleep ▪ Excessive daytime sleepiness ▪ Fatigue ▪ Nightmares ▪ Sleeping too much or too little	▪ ESS >10 ▪ ISI >11 ▪ NSI questions 17, 18	▪ Sleep disruption can exacerbate other symptom clusters and may prolong recovery ▪ Sleep Disturbances Following mTBI Clinical Recommendation
Vestibular	▪ Decreased coordination ▪ Dizziness/vertigo ▪ Loss of balance ▪ Motion sensitivity ▪ Nausea ▪ Nystagmus	▪ NSI questions 1–3, 8 ▪ VOMS Abnormal Vestibular/Ocular Reflex or Visual Motion Sensitivity testing	▪ If appropriate, evaluate and treat benign paroxysmal positional vertigo ▪ Dizziness Following mTBI Clinical Recommendation ▪ VOMS Visual Guide

K. Specialty Referral Guidance:

- Patients who do not respond to initial management and have symptoms persisting >15 days may benefit from referral to TBI specialty clinic, if available, or specialties listed below.

Symptom Cluster	Specialty Referral
Anxiety/ Mood	**Behavioral Health** ▪ Consider early referral in cases of acute stress reaction that do not rapidly resolve with simple measures ▪ Evaluation of new or premorbid behavioral health conditions
Cervical	**Physical Medicine and Rehabilitation (PM&R)** ▪ Assessment of persistent neck pain with comorbid chronic pain or persistent headache secondary to musculoskeletal dysfunction **Physical Therapy** ▪ Assessment and treatment of persistent neck pain following mTBI
Cognitive	**Neuropsychology** ▪ Formal evaluation to determine a need for work/home/school accommodations **Occupational Therapy** ▪ Strategies for daily living, functional cognition interventions, adaptive equipment/technology, driving evaluations **Speech Language Pathology** ▪ Cognitive rehabilitation strategies, speech disfluencies, organizational strategies
Headache	**Neurology** ▪ Assessment of persistent headaches when: (a) the diagnosis is not clear, (b) headaches do not respond to traditional treatment or prevention strategies, (c) there is a significant unresolved disability due to headache, (d) prolonged or persistent aura, or (e) headaches with accompanied motor weakness **Neuro-Optometry** ▪ Evaluation of headaches secondary to visual changes or eye strain **Physical Medicine and Rehabilitation (PM&R)** ▪ Assessment of persistent headaches with comorbid chronic pain or persistent headache secondary to musculoskeletal dysfunction
Oculomotor	**Neuro-Optometry** ▪ Assessment of visual disturbances that started or worsened after mTBI **Occupational Therapy** ▪ Strategies for daily living, functional vision interventions, adaptive equipment/technology, driving evaluations
Sleep	**Behavioral Health** ▪ Evaluation of behavioral health conditions that may impact sleep **Sleep Medicine** ▪ Evaluation of persistent or chronic sleep disturbance
Vestibular	**Vestibular Therapy** ▪ Specialized physical or occupational therapy to alleviate dizziness and other problems associated with vestibular disorders

L. Return To Duty (RTD) Screening:

- Before returning to full duty, SM should pass the Physical AND Cognitive RTD Screenings to ensure mission readiness.
- These tests should be performed after the service member has spent a minimum of 24 hours in Stage 5 without new or worsening symptoms.
- The purpose of the RTD screening is to give the provider a way to objectively measure readiness for return to duty. This may be used in conjunction with patient's subjective history of tolerated physical and cognitive activities.
- Consider MOS/NEC/AFSC service specific return to duty requirements (e.g. flight status, dive status, jump status, etc.) prior to RTD.

Physical RTD Screening:

- Physical exertion testing may be done in office, gym, or PT area.
- Have the service member perform 2 minutes of supervised aerobic activities at an exertion rate of 16 or greater on Borg RPE (Appendix C).
  - Preferred activities include modified burpees, sit-ups, or jumping jacks, as these activities will stress the vestibular system. Other activities may include high-knees, step-ups, push-ups, running, elliptical, or exercise bike.
  - Consider simulating combat environment if in a deployed setting.
  - Consider integrating MOS/NEC/AFSC specific-tasks and duty requirements.
- During exertion, observe service member for overt symptom provocation. If symptoms worsen, stop the test:
  - Remain in Stage 5 and re-test in 48–72 hours as appropriate.
  - Refer to Symptom-Guided Management while awaiting re-test.
- If the re-test is abnormal, refer to higher level of care based on Specialty Referral Guidance.
- If the Physical RTD Screening is normal, proceed to the Cognitive RTD Screening.

Cognitive RTD Screening:

- The preferred neurocognitive screening is the Automated Neuropsychological Assessment Metrics (ANAM). If ANAM is unavailable, repeat the Cognitive Exam portion of the MACE 2 (Questions 5–16).
- See ANAM Guidance (Appendix D) for further information.

M. Mandatory 24-hour SIQ/Quarters: Per DoDI 6490.11, service members involved in a potentially concussive event during deployment are required to rest for 24 hours, beginning at the time of the event. In certain circumstances, these recommendations can be superseded based on commanders' determination of mission requirements.

N. TBI Coding Guidance: Refer to TBICoE online resource for specific coding instruction.

ACRONYMS			
AFSC	Air Force Specialty Code	**ANAM**	Automated Neuropsychological Assessment Metrics
ASD	Acute Stress Disorder	**CNS**	Central Nervous System
CPG	Clinical Practice Guideline	**CT**	Computed Tomography
DoD	Department of Defense	**DoDI**	Department of Defense Instruction
EHR	Electronic Health Record	**GAD-7**	General Anxiety Disorder-7
HIT-6	Headache Impact Test-6	**MACE 2**	Military Acute Concussion Evaluation 2
MOS	Military Occupational Specialty	**NEC**	Navy Enlisted Classification
NSAIDs	Nonsteroidal Anti-Inflammatory Drugs	**NSI**	Neurobehavioral Symptom Inventory
PCM	Primary Care Manager	**PHQ-9**	Patient Health Questionaire-9
PRA	Progressive Return to Activity	**PTSD**	Post-Traumatic Stress Disorder
RTD	Return to Duty	**SIQ**	Sick in Quarters
SM	Service Member	**TBICoE**	Traumatic Brain Injury Center of Excellence
VA	Veterans Affairs	**VOMS**	Vestibular Oculomotor Screening

References/Acknowledgements: Please click here for a full list of references and acknowledgments.

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800-870-9244 | Health.mil/TBICoE

Appendix A: Neurobehavioral Symptom Inventory (NSI)

Neurobehavioral Symptom Inventory (NSI)
Instructions: Please rate the following symptoms with regard to how much they have disturbed you **SINCE YOUR INJURY**.
0 = None: Rarely if ever present; not a problem at all.
1 = Mild: Occasionally present, but it does not disrupt my activities; I can usually continue what I'm doing; doesn't really concern me.
2 = Moderate: Often present, occasionally disrupts my activities; I can usually continue what I'm doing with some effort; I feel somewhat concerned.
3 = Severe: Frequently present and disrupts activities; I can only do things that are fairly simple or take little effort; I feel I need help.
4 = Very Severe: Almost always present and I have been unable to perform at work, school or home due to this.

Symptom	**None**	**Mild**	**Moderate**	**Severe**	**Very Severe**
1. Feeling dizzy	0	1	2	3	4
2. Loss of balance	0	1	2	3	4
3. Poor Coordination, clumsy	0	1	2	3	4
4. Headaches	0	1	2	3	4
5. Nausea	0	1	2	3	4
6. Vision problems, blurring, trouble seeing	0	1	2	3	4
7. Sensitivity to light	0	1	2	3	4
8. Hearing difficulty	0	1	2	3	4
9. Sensitivity to noise	0	1	2	3	4
10. Numbness or tingling on parts of my body	0	1	2	3	4
11. Change in taste and/or smell	0	1	2	3	4
12. Loss of appetite or increased appetite	0	1	2	3	4
13. Poor concentration, can't pay attention, easily distracted	0	1	2	3	4
14. Forgetfulness, can't remember things	0	1	2	3	4
15. Difficulty making decisions	0	1	2	3	4
16. Slowed thinking, difficulty getting organized, can't finish things	0	1	2	3	4
17. Fatigue, loss of energy, getting tired easily	0	1	2	3	4
18. Difficulty falling or staying asleep	0	1	2	3	4
19. Feeling anxious or tense	0	1	2	3	4
20. Feeling depressed or sad	0	1	2	3	4
21. Irritability, easily annoyed	0	1	2	3	4
22. Poor frustration tolerance, feeling easily overwhelmed by things	0	1	2	3	4
The purpose of this inventory is to track symptoms over time. Please do not attempt to score.					

Cicerone, K. D., & Kalmar, K. (1995). Persistent postconcussion syndrome: The structure of subjective complaints after mild traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 10, 1–17. https://dx.doi.org/10.1097/00001199-199510030-00002

Appendix B: Patient and Leadership Guide (PLG)

Progressive Return to Activity Following Concussion/mTBI Patient and Leadership Guide (PLG)

FROM: _____ **TO:** _____ **DATE:** _____

RANK/NAME/UNIT: _____ **DoD ID#:** _____

DIAGNOSIS: Concussion/mTBI **Signature:** _____

DUTY STATUS:

Quarters: ❑ 24 hours ❑ 48 hours ❑ 72 hours

Light Duty/Profile (per stages chart) for ___ days

Follow-up Dates/Times: _____

NOTES: _____

_____

_____

Follow-up:

The above service member (SM) has been diagnosed with a concussion, or mild traumatic brain injury (mTBI), and will be following the TBICoE Progressive Return to Activity (PRA) Protocol throughout recovery. This process is unique in that the SM will progress at their own pace through the protocol but will have a **scheduled follow-up** with their provider **every three days**. Here are a few common questions related to concussions and this process:

What is the PRA?

The PRA is a six-step return to activity protocol. The earliest a SM can be returned to full duty after concussion is seven days. Following a gradual return to duty protocol has been shown to get SMs back to full duty safely and reduce long-term complications.

What could happen if a SM returns to duty too soon?

Returning a SM too soon places the SM and their unit at risk. Concussion can cause temporary disruption of mental and physical functioning, impairing reaction time, balance, marksmanship, etc. The SM should return to their primary care manager (PCM) and undergo a Return to Duty Screening before they may be returned to full duty.

What are common concussion symptoms?

Thinking/Remembering	Physical		Emotional/Mood	Sleep
Difficulty concentrating	Balance problems	Dizziness	Irritability	Excessive daytime sleepiness
Difficulty remembering new information	Feeling tired, having no energy	Fuzzy or blurry vision, difficulty reading	More emotional	Sleeping less than usual
Difficulty thinking clearly	Headache	Nausea or vomiting (early on)	Nervousness or anxiety	Sleeping more than usual
Feeling slowed down	Sensitivity to noise or light		Sadness	Trouble falling or staying asleep

What is the average recovery time from concussion/mTBI? When can the SM go back to work?

Most SMs fully recover from concussion. Recovery is different for each person, but most people are back to full duty in 2–4 weeks and will be treated solely by their PCM. However, some SMs may experience more severe symptoms that take longer to resolve and require a referral to a TBI Clinic or specialist.

How does a SM progress through the stages of the PRA?

The SM must spend at least 24 hours in each stage. At the beginning of each day the SM should evaluate how they feel:

- If symptoms are the same or better compared with the previous day **AND** they have no *new* symptoms — **they can move on to the next stage**
- If symptoms are worse compared with the previous day **OR** they have *new* symptoms – **they remain at the current stage for an additional 24 hours**

What does a SM do if there are new or worsening symptoms during the day?

Stop the activity until symptoms resolve. Then, return to the previously tolerated stage for the remainder of the day. The next day, reevaluate symptoms and continue progression through the PRA. Contact the provider with any questions or concerns.

Appendix B: Patient and Leadership Guide (PLG)

Stages of Progressive Return to Activity				
Stage	**Things Service Member *Should* Do**		**Things Service Member *Should Not* Do**	
Stage 1 – Relative Rest	▪ Light physical activities that don't make symptoms worse (e.g. walking at easy pace) ▪ Light leisure activities that don't make symptoms worse (e.g. TV, reading)	▪ Communicate with friends and family members for support ▪ Eat a healthy diet and drink plenty of water ▪ Get plenty of sleep, and take naps as needed in the early stages ▪ Maintain or reduce use of caffeine, energy drinks, and nicotine ▪ Take breaks if needed	▪ Do not go to work (SIQ/ Quarters) ▪ No physical training or exercise	▪ Do not go outside the wire in a combat zone ▪ No alcohol ▪ No combatives or contact sports ▪ No driving until dizziness or visual symptoms have resolved ▪ No weapons fire or blast exposure
Stage 2 – Symptom-Limited Activity	▪ Increase your physical activity (e.g. take a walk, ride a stationary bike without resistance, do light household activities) ▪ Light reading/computer work as tolerated		▪ Avoid crowded areas ▪ Avoid extreme temperatures ▪ No group physical training ▪ No resistance/weight training	
Stage 3 – Light Activity ▪ SM may be able to return to work at this stage with limitations based on symptoms	▪ Increase physical activities (e.g. elliptical or stationary bike without resistance, walk further, lift or carry light loads of less than 20 pounds) ▪ More technical reading and computer work, go out in more crowded areas (e.g. grocery shopping) ▪ Start military specific tasks (e.g. clean equipment, perform maintenance checks, clean weapons)		▪ No operating heavy machinery ▪ No resistance/weight training ▪ No riding in tactical vehicles ▪ No alternating shift work or shifts > 8 hours	
Stage 4 – Moderate Activity	▪ Increase physical activities (e.g. non-contact sports, hiking or running, resistance training as tolerated (e.g. push-ups, sit-ups), carry weight across uneven terrain) ▪ Increase complexity of military specific tasks (e.g. orienteering/land navigation, following complex instructions, begin wearing personal protective equipment as tolerated)		▪ No operating heavy machinery ▪ No riding in tactical vehicles ▪ No alternating shift work or shifts > 8 hours	
Stage 5 – Intensive Activity ▪ SM to follow up with PCM for Return to Duty Screening	▪ Gradually increase exposure to high risk activities (e.g. combatives, weapons fire or blast exposure, contact sports) in a supervised training environment based on mission requirements ▪ Resume usual exercise routine and military tasks/ training (e.g. use night vision goggles, take part in simulations, navigate uneven terrain/busy environment with flak jacket/Kevlar helmet/pack)		▪ No alternating shift work or shifts > 8 hours	
Stage 6 – Return to Full Duty	▪ Unrestricted activity			

Appendix C: Borg Rate of Perceived Exertion (RPE) Scale

Instructions: The Borg Rate of Perceived Exertion (RPE) is a way of measuring physical activity intensity level. When conducting the Physical RTD Screening, have the service member begin the activity and ask them to rate their level of exertion using the Borg RPE. When they reach a 14-16, begin the two minute timer.

6	**No exertion at all**
7–8	**Extremely light**
9	**Very light** exercise. For a healthy person, it is like walking slowly at his or her own pace for some minutes
10-12	**Light**
13	**Somewhat hard** exercise, but it still feels OK to continue.
14-16	**Hard** (heavy)
17-18	**Very Hard**. A healthy person can still go on, but he or she really has to push him- or herself. It feels very heavy, and the person is very tired.
19	**Extremely strenuous** exercise level. For most people this is the most strenuous exercise they have ever experienced
20	**Maximal exertion**

Borg, G. (1982). Psychophysical bases of perceived exertion. *Medicine and Science in Sports and Exercise*, 14 (5), 377 – 81.

Appendix D: ANAM Guidance

How to Request ANAM

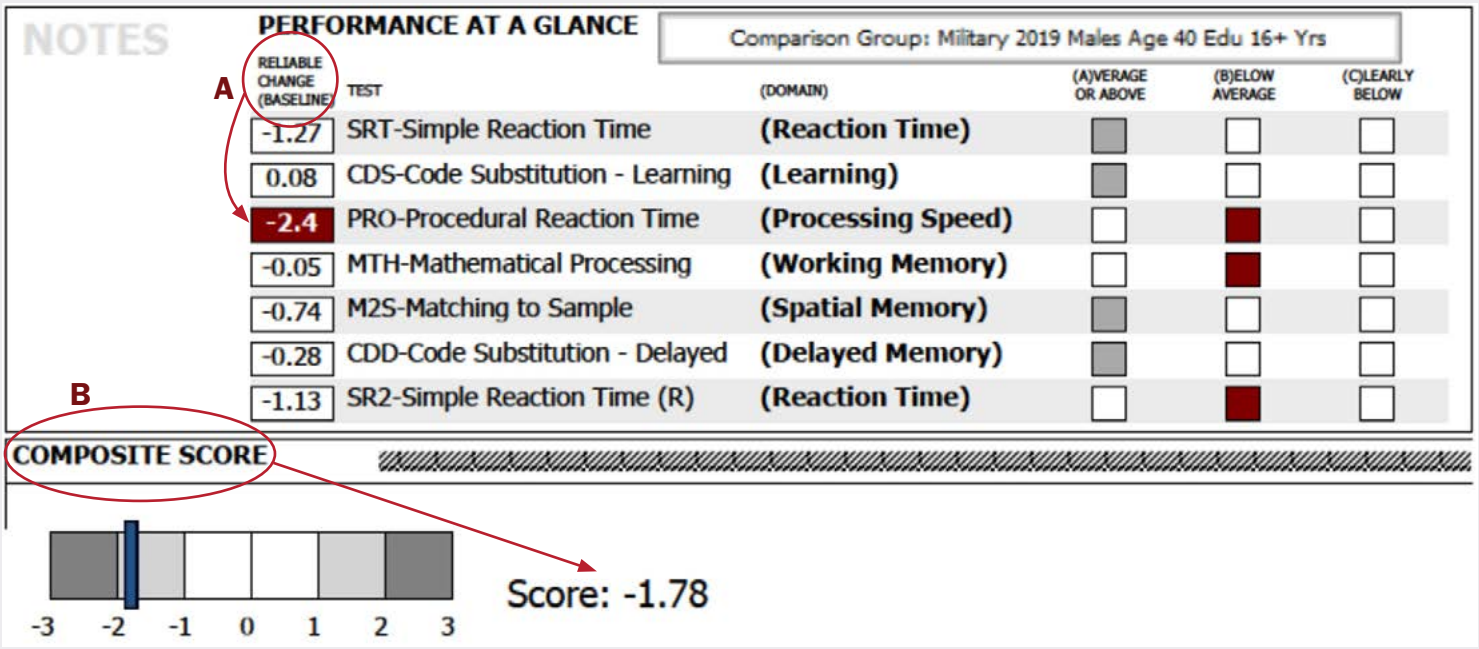
1. Call ANAM Help Desk
   - Phone number: 1-855-630-7849 (toll free)
   - Hours of Operation: 24 hours, 365 days
2. Send a request to ANAM Results Request Inbox (cannot be encrypted): usarmy.jbsa.medcom.mbx.otsg--anam-baselines@mail.mil

Interpretation of the ANAM Clinical Report

A. If service member **has a baseline ANAM**, refer to the Reliable Change scores for each subtest. If the Reliable Change is less than -1.64 on any one subtest (appearing in a red box), or less than -1.28 on 2 or more subtests, remain in Stage 5 and repeat ANAM in 48–72 hours.

B. If service member **does not have a baseline ANAM**, refer to the overall Composite Score. If the Composite Score is less than -1.64, remain in Stage 5 and repeat ANAM in 48-72 hours.

Example ANAM Report


NOTES
PERFORMANCE AT A GLANCE
Comparison Group: Military 2019 Males Age 40 Edu 16+ Yrs
A
RELIABLE CHANGE (BASELINE)
TEST
(DOMAIN)
(A)VERAGE OR ABOVE
(B)ELOW AVERAGE
(C)LEARLY BELOW
-1.27 SRT-Simple Reaction Time (Reaction Time)
0.08 CDS-Code Substitution - Learning (Learning)
-2.4 PRO-Procedural Reaction Time (Processing Speed)
-0.05 MTH-Mathematical Processing (Working Memory)
-0.74 M2S-Matching to Sample (Spatial Memory)
-0.28 CDD-Code Substitution - Delayed (Delayed Memory)
-1.13 SR2-Simple Reaction Time (R) (Reaction Time)
B
COMPOSITE SCORE
-3 -2 -1 0 1 2 3
Score: -1.78

- If service member does not meet criteria for return to duty after second attempt, refer to Neuropsychologist/ Speech Language Pathologist (SLP) for further evaluation.
- The ANAM Help Desk can answer general questions. For questions regarding ANAM interpretation, please consult a Neuropsychologist or specialist.

If ANAM is unavailable, repeat the Cognitive Exam portion of the MACE 2 (Questions 5-16)

- SM should score > 25 to be considered ready to return to full duty.
- If SM scores ≤ 25, remain in Stage 5 and repeat in 48-72 hours.
- If the score continues to be ≤ 25, refer for ANAM (see above) or to Neuropsychologist/Speech Language Pathologist (SLP) for further evaluation.

Appendix E: PRA Frequently Asked Questions (FAQs)

Responses to frequently asked questions are listed below to assist providers in implementation of the PRA.

GENERAL:

Question: What is the PRA?

Answer: The PRA is a gradual, evidence-based protocol that facilitates return-to-duty in a six-stage process. The earliest a SM can progress through all six stages and be returned to full duty is 7 days after concussion.

Question: Why should I use a PRA protocol after concussion?

Answer: Following a step-wise return to duty protocol has been shown to get SMs back to full duty safely and reduce long-term complications. Returning a SM too soon places the individual and their unit at risk. Concussion can cause temporary disruption of mental and physical functioning, impairing reaction time, balance, marksmanship, etc. The SM should return to their medical provider and undergo a Return to Duty Screening before they may be returned to full duty.

Question: Which patients can benefit from the PRA?

Answer: The PRA is designed for use in active-duty SMs who have sustained a concussion/mTBI. However, the PRA is appropriate for concussion recovery in civilians or reservists and can be utilized by modifying the activities in each stage to meet the patient's needs or lifestyle.

PRA ALGORITHM & PROGRESSION:

Question: Why are the first 3 boxes of the algorithm shaded a different color from the rest of the algorithm and what is their significance?

Answer: The PRA CR has incorporated aspects of the MACE 2 and combined the 2014 PRA for Primary Care Managers, the 2014 PRA for Rehabilitation Providers, and the Concussion Management Tool (CMT) into the PRA Algorithm, creating a more comprehensive product to manage concussion from point of injury to return to full duty. The MACE 2 and components of the CMT are typically used prior to entering the PRA protocol. To indicate this, we shaded the initial management steps a different color. Often, these actions are taken by providers/corpsman/medics that are outside of the SM's usual medical facility (i.e. emergency department or branch clinic).

Question: What special considerations should I make with SMs that have sustained multiple concussions in the past 12 months?

Answer: When considering the number of concussions the patient has had in the past 12 months, include the current concussion in that number. Per DoDI 6490.11, deployed SMs who have experienced two concussions in the last 12 months must spend a minimum of seven days in the PRA protocol prior to return to full duty. SMs who have experienced 3 or more concussions in the last 12 months must be referred for Recurrent Concussion Evaluation. The SM must stop progression at Stage 5 and can only be returned to full duty (Stage 6) by a specialist.

Question: Why are SMs treated differently if deployed?

Answer: If a SM is exposed to a potentially concussive event (PCE) while *deployed*, DoD Instruction (DoDI) 6490.11 mandates 24 hours of rest. If the SM is exposed to a PCE while in *garrison* and *does not* meet criteria for a concussion (i.e. mechanism of injury and AOC, LOC, or PTA), 24 hours rest is not mandatory but is still encouraged.

Question: What would you recommend for a SM who is advancing in one area (e.g. physical activity) but struggling in another area (e.g. cognitive activity)?

Answer: A SM should tolerate activities in both physical/vestibular and cognitive/oculomotor categories prior to advancing to the next stage of the PRA. The PCM should use the Symptom-Guided Management table to address specific areas with high symptom burden.

Question: How do you treat a SM who has delayed in presenting to their PCM for days or weeks after a PCE?

Answer: First, determine if they have been evaluated for a concussion (e.g. in the emergency department) and if a MACE 2 has been completed. If a MACE 2 has not been completed, consider performing at the initial evaluation. Then enter the algorithm at the large rectangle labeled "Initiate PRA Stage 1." Follow the instructions, but rather than beginning at Stage 1, evaluate at which stage the SM should enter the PRA based on the timeframe since the injury and the SM's activity level and symptoms. Example: It has been seven days since the SM was injured and seen in the ED where a MACE 2 was performed and documented in the EHR. The SM's overall NSI score is very low (e.g. one for headache and one for dizziness and zeros for all other symptoms), and it is their first concussion in the past 12 months. They report being able to run a half mile before feeling a worsening headache and being able to do push-ups, pull-ups, and light resistance training. Based on these criteria, the SM could enter the PRA at Stage 4 and progress per regular instructions.

Question: I'm concerned that my patient won't be able to see me every three days. Are there recommendations for how to accomplish this?

Answer: We strongly recommend scheduling at least five follow-up appointments (every three days) at their first visit. Since the average recovery time for concussion is 15 days, this allows the SM to provide dates and times to their chain of command for awareness and planning. Most patients will complete the entire PRA progression in this time period, though some may require additional recovery time (see risk factors for protracted recovery below). You can also consider utilizing telehealth appointments with the PCM or trained support staff to complete follow-up visits. However, RTD screening will require an in-person appointment.

Appendix E: PRA Frequently Asked Questions (FAQs)

RETURN TO DUTY CONSIDERATIONS:

Question: What is the Borg scale and how does it compare to heart rate monitoring during exercise?

Answer: The Borg Rating of Perceived Exertion (RPE) scale helps estimate how hard someone is working (activity intensity). The Borg RPE can be multiplied by 10 to get a fairly good estimate of the individual's actual heart rate.[1] For example, if the SM is on a treadmill and reports a 13 (Somewhat hard, but it still feels OK to continue), their estimated heart rate would be 13 x 10 = 130 bpm. Because this is only an *approximation* of heart rate, the actual heart rate can vary depending on age and physical condition.

Question: Why is the ANAM part of the RTD screening? What if the ANAM is not available in my setting?

Answer: Growing evidence supports the importance of both cognitive and physical readiness for return to duty. The ANAM is a neurocognitive assessment tool that has been normed and validated in military SMs. Additionally, many SMs have a baseline ANAM score from before their concussion, which allows for comparison. Thus, the ANAM provides the best evaluation of a SM's cognitive function in relation to their peers and their own pre-concussion performance. If the ANAM is not available, you can either refer to a nearby MTF that has ANAM testing or repeat the cognitive exam portion of the MACE 2.

Question: I'm deployed, and we need the SM back to duty before they have completed the full PRA for mission readiness. What should I do?

Answer: This clinical recommendation is intended to serve as a guideline, and while strongly encouraged to promote a safe recovery for concussed SMs, these recommendations may be superseded at medical or command discretion.

ADDITIONAL CONSIDERATIONS:

Question: Why should we avoid using tramadol, acetaminophen/caffeine/butalbital, and opioids in the acute stages of concussion?

Answer: All of these medications can cause CNS depression and alter cognitive function, which can mimic other conditions associated with traumatic brain injury (e.g. intracranial bleed) and obscure the clinical course of TBI. The sedating effects of these medications can also be intensified in patients with head injury.[2] In addition, all of these medications carry high risk of dependence, tolerance, and medication overuse (rebound) headaches. Lastly, tramadol and opioids can cause nausea and vomiting, and tramadol may increase the risk of seizures.

Question: Why should we wait 48 hours before using nonsteroidal anti-inflammatory drugs (NSAIDs) for treatment of post-traumatic headache?

Answer: Use of NSAIDs for post-traumatic headache should be delayed for 48 hours following concussion due to their anti-platelet effect and the potential risk of exacerbating an evolving intracranial bleed.

Question: Why should SMs minimize consumption of caffeine/energy drinks and nicotine and avoid alcohol after a concussion?

Answer: There is limited evidence on the impact of caffeine, energy drinks, nicotine, and alcohol on concussion recovery. However, these substances can cause dehydration, disrupt sleep patterns, and worsen post-concussion symptoms resulting in a delay in return to duty. Abrupt cessation of caffeine or nicotine may result in withdrawal symptoms, therefore, we recommend SMs minimize or maintain their pre-injury levels of these substances. We recommend abstinence from alcohol as any use may exacerbate concussion symptoms including headache, dizziness, nausea, vomiting, fatigue, cognitive disturbances, depression and anxiety. Additionally, excessive alcohol use may increase fall risk, which places a SM at higher risk for a 2nd concussion.

Question: My patient is not progressing or is progressing very slowly. What are the risk factors for protracted recovery?

Answer: There are several risk factors, both pre- and post-traumatic, associated with protracted recovery following concussion. The most consistent predictor of delayed recovery is the severity of acute and subacute symptoms.[3] Pre-traumatic factors include female sex, history of concussion, migraine headaches, sleep disorders, and psychological conditions (including PTSD, anxiety, depression, ADHD, and substance abuse).[4,5,6] Post-traumatic factors include post-traumatic migraine/headache and acute dizziness.[3,4] Particularly relevant in the military population is the prevalence of PTSD and its potential impact on concussion recovery. The risk for PTSD is elevated two-to-three fold following concussion, and the prevalence of co-morbid PTSD and TBI has been reported to range from 10-40%.[7,8] During early concussion care, providers should be aware of risk factors for PTSD, including acute stress disorder (ASD), which is diagnosed when acute stress reaction (ASR) or combat or operational stress reaction (COSR) persists beyond three days. Refer to the VA/DoD PTSD and ASD Clinical Practice Guideline for more information on ASR, ASD, and PTSD.

Question: When is it safe for a SM to have sexual intercourse following a concussion?

Answer: Sexual activity can be slowly reintroduced, as with other strenuous activity, during progression through the stages. It is safe to have sex when the SM is able to do so without exacerbating symptoms. Consider fatigue, mood, and dizziness in addition to other physical symptoms. During recovery, SMs may wish to modify sexual activity (e.g. position, frequency, intensity) in order to minimize symptoms.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Prolonged Casualty Care Guidelines (CPG ID:91)

The Prolonged Casualty Care (PCC) guidelines are a consolidated list of casualty-centric knowledge, skills, and best practices intended to serve as the DoD baseline clinical practice guidance to guide casualty management over a prolonged amount of time in austere, remote, or expeditionary settings, and/or during long-distance movements.

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Rapid Update (Jun 2023): removal of Promethazine recommendation in accordance with DHA Policy Memo 23-001 Discontinuation of Injectable Promethazine Usage at MTFs.

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PROLONGED CASUALTY CARE BACKGROUND

***Prolonged Casualty Care (PCC)**: The need to provide patient care for extended periods of time when evacuation or mission requirements surpass available capabilities and/or capacity to provide that care.*

The PCC guidelines are a consolidated list of casualty-centric knowledge, skills, abilities, and best practices intended to serve as the DoD baseline clinical practice guidance (CPG) to direct casualty management over a prolonged period of time in austere, remote, or expeditionary settings, and/or during long-distance movements. These PCC guidelines build upon the DoD standard of care for non-medical and medical first responders as established by the Committee on Tactical Combat Casualty Care (CoTCCC), outlined in the Tactical Combat Casualty Care (TCCC) guidelines,[1] and in accordance with (IAW) DoDI 1322.24.

The guidelines were developed by the PCC Work Group (PCC WG). The PCC WG is chartered under the Defense Committee on Trauma (DCoT) to provide subject matter expertise supporting the Joint Trauma System (JTS) mission to improve trauma readiness and outcomes through evidence-driven performance improvement. The PCC WG is responsible for reviewing, assessing, and providing solutions for PCC-related shortfalls and requirements as outlined in DoD Instruction (DoDI) 1322.24, *Medical Readiness Training, 16 Mar 2018*, under the authority of the JTS as the DoD Center of Excellence pursuant to DoDI 6040.47, *JTS*, 05 Aug 2018.

Operational and medical planning should seek to avoid categorizing PCC as a primary medical support capability or control factor during deliberate risk assessment; however, an effective medical plan always includes PCC as a contingency. Ideally, forward surgical and critical care should be provided as close to casualties as possible to optimize survivability.[2] DoD units must be prepared for medical capacity to be overwhelmed, or for medical evacuation to be delayed or compromised. When contingencies arise, commanders' casualty response plans during PCC situations are likely to be complex and challenging. Therefore, PCC planning, training, equipping, and sustainment strategies must be completed prior to a PCC event. The following evidence-driven PCC guidelines are designed to establish a systematic framework to synchronize critical medical decisions points into an executable PCC strategy, regardless of the nature of injury or illness, to effectively manage a complex patient and to advise commanders of associated risks.

The guidelines build upon the accepted TCCC categories framed in the novel MARC^{2}H^3-PAWS-L treatment algorithm, (Massive Hemorrhage/MASCAL, Airway, Respirations, Circulation, Communications, Hypo/Hyperthermia and Head Injuries, Pain Control, Antibiotics, Wounds (including Nursing and Burns), Splinting, Logistics).

The PCC guidelines prepare the Service Member for "what to consider next" after all TCCC interventions have been effectively performed and should only be trained after having mastering the principles and techniques of TCCC.

The guidelines are a consolidated list of casualty-centric knowledge, skills, abilities, and best practices are the proposed standard of care for developing and sustaining DoD programs

MARC^{2}H^3-PAWS-L

Massive Hemorrhage/MASCAL
Airway
Respirations
Circulation
Communication
Hypothermia/Hyperthermia
Head Injury
Pain Control
Antibiotics
Wounds (+ Nursing/Burns)
Splinting
Logistics

required to enhance confidence, interoperability, and common trust among all PCC-adept personnel across the Joint force.

The JTS CPGs are foundational to the PCC guidelines and will be referenced throughout this document in an effort to keep these guidelines concise. General information on the Joint Trauma System is available on the JTS website (https://jts.health.mil/) and links to all of the CPGs are also available by using the following link: https://jts.health.mil/index.cfm/PI_CPGs/cpgs.

The TCCC guidelines are included in these guidelines as an attachment because they are foundational AND prerequisite to effective PCC. Remember, the primary goal in PCC is to get out of PCC!!!

PCC Principles

The principles and strategies of providing effective prolonged casualty care are meant to help organize the overwhelming amount of critical information into a clear clinical picture and proactive plan regardless of the nature of injury or illness. The following steps can be implemented in any austere environment from dispersed small team operations in permissive environments to large scale combat operations to make the care of a critically ill patient more efficient for the medic and their team. These mimic the systems and processes in typical intensive care units without relying on technology while leaving the ability to add technological adjuncts as they become available. The following checklist is meant to emphasize some of the most important principles in efficient care of the critically ill patient.

Figure 1. Steps of PCC Principles

1.1. Address and reassess all immediate life threats and interventions per current CoTCCC guidelines before moving onto prolonged casualty care (PCC) considerations.
1.2. Re-triage as required if caring for multiple patients using appropriate triage decision tool.
1.3. Confirm that notifications of the incident and requests for evacuation have been sent and received through the proper channels. This must be evaluated no later than the "C-Communications" in MARC³H³PAWS
1.4. When in doubt refer back to the initial assessment and treatments per current TCCC guidelines

1. **Perform initial lifesaving care using TCCC guidelines and continue resuscitation.**
   The foundation of good PCC is mastery of TCCC and a strong foundation in clinical medicine.
2. **Delineate roles and responsibilities, including naming a team leader.**
   A leader should be appointed who will manage the larger clinical picture while assistants focus on attention intensive tasks.
3. **Perform comprehensive physical exam and detailed history with problem list and care plan.**
   After initial care and stabilization of a trauma or medical patient, a detailed physical exam and history should be performed for the purpose of completing a comprehensive problem list and corresponding care plan.
4. **Record and trend vital signs.**
   Vital signs trending should be done with the earliest set of vital signs taken and continued at regular intervals so that the baseline values can be compared to present reality on a dedicated trending chart.
5. **Perform a teleconsultation.**
   As soon as is feasible, the medic should prepare a teleconsultation by either filling out a preformatted script or by writing down their concerns along with the latest patient information.
6. **Create a nursing care plan.**
   Nursing care and environmental considerations should be addressed early to limit any provider-induced iatrogenic injury.
7. **Implement team wake, rest, chow plan.**
   The medic and each of their first responders should make all efforts to take care of each other by insisting on short breaks for rest, food, and mental decompression.
8. Anticipate resupply and electrical issues
9. **Perform periodic mini rounds assessments.**
   Stepping back from the immediate care of the patient periodically and re-engaging with a mini patient round and review of systems can allow the medic to recognize changes in the condition of the patient and reprioritize interventions.
   - Is the patient stable or unstable?
   - Is the patient sick or not sick?
   - Is the patient getting better or getting worse?
   - How is this assessment different from the last assessment?
10. **Obtain and interpret lab studies.**
    When available, labs may be used to augment these trends and physical exam findings to confirm or rule out probable diagnoses.
11. **Perform necessary surgical procedures.**
    The decision to perform invasive and surgical interventions should consider both risks and benefit to the patient's overall outcome and not merely the immediate goal.
12. **Prepare for transportation or evacuation care.**
    If the medic is caring for the patient over a long tactical move or strategic evacuation, they should be prepared with ample drugs, fluids, supplies and be ready for all contingencies in flight.

13. **Prepare documentation for patient handover.**
    The preparation for transportation and evacuation care should begin immediately upon assuming care for the patient and should include hasty and detailed evacuation requests up both the medical and operational channels with the goal of getting the patient to the proper role of care as soon as possible.

Guideline User Notes

PCC operational context uses the following paradigm for phases of care for different periods of time one is in a PCC scenario:

Table 1. Roles of Care

Role	Definition	Time Period
1a	Carried/Point of Need/Ruck	<1 Hour
1b	Mission-specific transportation platform/Truck	1-4 Hours
1c	Mission support site/House	>4 Hours
1d	Evacuation platform/Plane (as planned or available)	No Timeframe

Where appropriate, a minimum-better-best format is included for situations in which the operational reality precludes optimal care for a given scenario:

- **Minimum**: This is the minimum level of care which should be delivered for a specified level of capability
- **Better**: When available or practical, this includes treatment strategies or adjuncts that improve outcomes while still not considered the standard of care.
- **Best**: This is the optimal medical for a given scenario based on the level of medical expertise of the provider

Expectations of prehospital care, based on TCCC's role-based standard of care, are included within each section:

- **Tier 1**: This is the basic medical knowledge for all service-members.
- **Tier 2**: Those who have been through approved CLS training are expected to be able to meet the standards at this level of care.
- **Tier 3** (Combat Medics/Corpsmen [CMC]): Those who are trained medics/corpsmen are expected to meet the medical standards for this tier.
- **Tier 4** (Combat Paramedic/Provider [CPP]): This is the highest level of prehospital capability and will have a significantly expanded scope of practice.

MASCAL/TRIAGE - PCC

Background

The foundation of effective PCC is accurate triage for both treatment in the PCC setting and for transportation to a higher level of care, as well as effective resource management across the entire trauma system. Resource management includes the appropriate utilization of medical and non-medical personnel, equipment and supplies, communications, and evacuation platforms. Like most Mass Casualty incidents (MASCAL), the purpose of triage in a PCC setting is to swiftly identify casualty needs for optimal resource allocation in order to improve patient outcomes. However, PCC presents unique and dynamic triage challenges while managing casualties over a prolonged period with a low likelihood of receiving additional medical supplies or personnel with enhanced medical capabilities apart from pre-established networks. MASCAL in a PCC environment will necessitate more conservative resource allocation than traditional MASCAL in mature theaters or fixed medical facilities where damage control surgery, intensive care, and medical logistical support are more readily available, and resupply is more likely. PCC dictates the need for implementing various triage and resource management techniques to ensure the greatest good for all. The objectives and basic strategies are the same for all MASCAL; however, tactics will vary depending on the available resources and situations.

MASCAL Decision Points

1. Determine if a PCC MASCAL is occurring – do the requirements for care exceed capabilities?
    - What is the threat? Has it been neutralized or contained? If not, security takes priority.
    - What is the total casualty estimate?
    - Are there resource limitations that will affect survival?
    - Can medical personnel arrive at the casualty location, or can the casualty move to them?
    - Is evacuation possible?
    - Communicate the situation to all available personnel conducting or enabling PCC.
    - Assess requirements for which class of triage you are facing (see Appendix C) and scale medical action to maximize lethality then survivability.
    - Remain agile and be ready to move based on the mission.
2. Determine if conditions require significant changes in the commonly understood and accepted standards of care (Crisis Standards of Care)[3] or if personnel who are not ordinarily qualified for a particular medical skill will need to deliver care. MASCAL in PCC requires both medical and non-medical responders initially save lives and preserve survivable casualties. Both groups will need skills traditionally outside existing paradigms, such as non-medical personnel taking and record vital signs or Tier 3 TCCC medical personnel maintaining vent settings on a stable patient. The MASCAL standard of care will be driven by the volume of casualties, resources, and risk or mortality/morbidity due to degree of injury/illness; as such, remain agile throughout the MASCAL and trend in both directions based upon resources available.
3. MASCAL management is often intuitive and reactive (due to lack of full mission training opportunities) and should rely on familiar terminology and principles. Treatment and casualty movement should be rehearsed to create automatic responses.

4. The tactical and strategic operational context will underpin every facet of MASCAL in a PCC environment, operational commanders MUST be involved in every stage of MASCAL response (The mere fact that a medical professional or team of medical professionals is forced to hold a casualty longer than doctrinal planning timelines means there is a failure in the operational/logistical evacuation chain. Battle lines, ground-to-air threat, etc. levels may have shifted.)
5. Logistical resupply may need to include non-standard means and involve personnel and departments not typically associated with Class VIII in other situations (i.e. aerial resupply, speedballs, caches, local national market procurement).
6. The most experienced person should establish MASCAL roles and responsibilities, as appropriate.

Key Considerations in MASCAL

- Usually, simpler is better.
- Focus on those that will preserve scarce resources, such as blood.
- Triage is a continuous process and should be repeated as often as is clinically and operationally practical.
- Avoid high resource and low yield interventions.
- Emergency airway interventions should prioritize REVERSIBLE pathology in salvageable patients.
- Decisions will depend on available resources and skillsets (i.e. penetrating traumatic brain injury [TBI] triaged differently if no neurosurgery is available in a timely manner or at all in theater).
- Conserve, ration, and redistribute additional scarce resources (i.e. blood, drug).

MASSIVE HEMORRHAGE - PCC

Background

Early recognition and intervention for life-threatening hemorrhage are essential for survival. The immediate priorities are to control life-threatening hemorrhage and maintain vital organ perfusion with rapid blood transfusion.[4]

Pre-deployment, Mission Planning, and Training Considerations

1. Conduct unit level blood donor testing (for blood typing, transfusion transmitted diseases and Low Titer blood type O titers) and develop operational roster.
2. Define Cold Chain Stored Whole Blood (CSWB) distribution quantities in area of responsibility.
3. Manage and equip prehospital blood storage program if unit policies and procedures allow for prehospital blood storage.

Table 2. PCC Role-Based Guidelines for Massive Hemorrhage Management

PCC Role-based Guidelines for Massive Hemorrhage Management				
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	**** All Personnel - Complete Basic TCCC Management Plan for Massive Hemorrhage then:*** ▪ Identify life-threatening bleeding that may have started or was not adequately controlled with initial interventions in TCCC Basic Management Plan for Massive Hemorrhage. ▪ Check tourniquets to ensure that they have not shifted or loosened.
				▪ Re-assess and re-apply MARCH interventions. ▪ Perform all recommended interventions from guidelines for above tier level.
				▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Role 1a** ▪ Conduct Triage – Time Assessment. ▪ Assess extremities distal to pressure dressings to ensure that they are not acting as a venous tourniquet which could result in compartment syndrome by checking pulses and the skin color distal to the dressing. ▪ Communicate evacuation and re-supply requirements (i.e. Blood resupply/Speedball). ▪ Administer Calcium and Tranexamic Acid (TXA) per TCCC guideline.
				Role 1b ▪ Re-assess and re-apply MARCH interventions. ▪ Consider tourniquet conversion (> 2 hours but before 6 hours). ▪ Assess for refractory shock – see Circulation Section.
				Role 1c ▪ Evaluate for compartment syndrome. ▪ Consider teleconsultation. ▪ Continue resuscitation until: min: palpable radial pulse or improved mental status better: SBP > 90 mmHg best: SBP between 100-110 mmHg. Discontinue fluid administration when one of the above end points have been achieved.

	▪ Ensure interventions noted above are completed by TCCC ASM, CLS and Combat Medic/Corpsmen (CMC) personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include:
	Role 1a Re-assess all prior MARCH interventions.
	Role 1b ▪ Assess using ultrasound (if available) including Extended Focused Assessment with Sonography in Trauma, Central Venous Pressure. ▪ Determine hypovolemia vs. refractory shock to drive decision on further resource utilization.
	Role 1c ▪ Convert to type-specific blood replacement, if testing available. ▪ Establish Foley catheter with goal Urine Output (UOP) of > ½ ml/kg per hour.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

Link to Damage Control Resuscitation (DCR) in Prolonged Field Care CPG, 01 Oct 2018 [5]

AIRWAY MANAGEMENT - PCC

Background

Airway compromise is the second leading cause of potentially survivable death on the battlefield after hemorrhage.[6] Complete airway occlusion can cause death from suffocation within minutes. Austere environments present significant challenges with airway management. Limited provider experience and skill, equipment, resources, and medications shape the best management techniques. Considerations include: limited availability of supplemental oxygen; medications for induction/rapid sequence intubation, paralysis, and post-intubation management; and limitations in available equipment. Another reality is limitations in sustainment training options, especially for advanced airway techniques. Due to these challenges, some common recommendations that may be considered "rescue" techniques in standard hospital airway management may be recommended earlier or in a non-standard fashion to establish and control an airway in a PCC environment. Patients who require advanced airway placement tend to undergo more interventions, be more critically injured, and ultimately have a higher proportion of deaths. The ability to rapidly and consistently manage an airway when indicated, or spend time on other resuscitative needs when airway management is not indicated, may contribute to improved outcomes.[7,8]

Table 3. PCC Role-based Guidelines for Airway Management

PCC Role-based Guidelines for Airway Management				
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	**** All Personnel - Complete Basic TCCC Management Plan for Airway then:*** Assess for airway problem; use patient positioning per TCCC guidelines to maintain open airway.
				▪ Re-assess airway interventions performed in TCCC. ▪ Positive end-expiratory pressure (PEEP) valves should be used anytime you are using a bag valve mask. ▪ Use nasal pharyngeal airway (NPA). ▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Role 1a** ▪ Airway adjuncts should be assessed for efficacy by checking the patient's work of breathing, end-tidal CO2 (ETCO2) and pulse oximetry levels. ▪ Level of sedation should be continuously assessed every 5 minutes for patients sedated deep enough for endotracheal intubation.
				Role 1b ▪ Re-asses airway before, after and during any patient movement. ▪ Airway adjuncts with an inflatable cuff such as ET or cricothyrotomy tube or inflatable laryngeal mask airways (LMA) should be assessed for proper inflation levels to ensure that they are not under or over inflated. ▪ Inflate the cuff with a 10cc syringe and then releasing your thumb from the plunger to let the plunger equalize.

		Role 1c ▪ Airway adjuncts with an inflatable cuff such as ET or cricothyrotomy tube or inflatable LMA should be assessed for proper inflation levels to ensure that they are not under or over inflated. ▪ Mechanical suction device and yankauer suction for suctioning out the oropharynx. ▪ Airway adjuncts should be assessed for efficacy by checking the patient's work of breathing, ETCO2 and pulse oximetry levels. ▪ Mouth care should be performed per the attached nursing care checklist in appendix.
	▪ Ensure above interventions are completed by TCCC ASM, CLS and CMC personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Role 1a** Re-assess all prior MARCH interventions.	
		Role 1b ▪ Re-assess cuff pressures per above. ▪ Continued assessment of patient's work of breathing, ETCO2 and pulse oximetry levels.
		Role 1c ▪ Inflate and periodically check cuff pressures with a cuff manometer to a goal of 20 mmHg. ▪ Use heat moisture exchanger to keep contaminants out and endogenous heat and moisture in the lungs. ▪ Inline suction catheter for suctioning airway adjunct as indicated.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

Link to Airway Management in Prolonged Field Care, 01 May 2020 [9]

RESPIRATION AND VENTILATION - PCC

Background

Respiration is the process of gas exchange at the cellular level. Oxygen is conducted into the lung and taken up by the blood via hemoglobin to be transported throughout the body. In the peripheral tissues, carbon dioxide is exchanged for oxygen, which is transported by the blood to the lungs, where it is exhaled. This process is essential to cellular and organism survival. Dysfunction of this process is a feature of multiple-injury patterns that can lead to increased morbidity and mortality.

Table 4. PCC Role-based Guidelines for Respiration Management

PCC Role-based Guidelines for Respiration Management	

TCCC-ASM, TCCC-CLS, TCCC-CMC, TCCC-CPP	**** All Personnel - Complete Basic TCCC Management Plan for Respiration then:***
	▪ Identify Respiratory distress.
	▪ Some Level 1 providers may be trained in Basic Life Support (BLS), and if so, may offer the following interventions:
	  ▪ Open the airway using Head Tilt or Jaw Thrust maneuver.
	  ▪ Provide rescue breaths per BLS.

TCCC-CLS, TCCC-CMC, TCCC-CPP	▪ Perform all recommended interventions from guidelines for above Tier level
	▪ Additional interventions include:
	  ▪ Use Bag Valve Mask with PEEP Valve.
	  ▪ Use NPA.

TCCC-CMC, TCCC-CPP	▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel.
	▪ Conduct inventory of all resources.
	▪ Document all pertinent information on PCC Flowsheet (attached).
	▪ Additional interventions include:
	  ▪ Target ventilation to pulse oximetry level of 92%; use supplemental oxygen if available.
	  ▪ Use end-tidal carbon dioxide monitor and maintain ETCO2 between 35-45 mmHg.
	  ▪ If definitive airway is required, consider cricothyrotomy tube as less sedation and pain management is required to facilitate a patent and secure method for respirations.

TCCC-CPP	▪ Ensure interventions noted above are completed by TCCC ASM, CLS, and CMC personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Mechanical Ventilation (For trained providers)** ▪ Use of mechanical ventilators in the PCC environment requires experience and training, best accomplished under board-certified medical personnel and sustained routinely. ▪ Ensure appropriate amount of induction, sedation, and pain management to sustain the patient for up to 96 hours in a PCC environment.
	Role 1a ▪ BVM, NPA, Pulse oximetry to maintain >92%. ▪ Intubate if no gag reflex and casualty is salvageable (TBI).
	Role 1b Add ETCO2 monitoring, goal 35-45 mmHg; initiate mechanical ventilation.
	Role 1c ▪ Establish sedation, pain management maintenance plan for >96 hours; use non-invasive ventilation as able. ▪ Monitor ABGs.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

Additional Considerations

- When in a PCC environment, simple monitoring technologies are able to be used by most providers in each of the provider categories to ensure adequate gas exchange and oxygen delivery. Peripheral oxygen saturation can be measured using a pulse oximeter which provides a measurement of hemoglobin saturation and, by inference, the effectiveness of measures to oxygenate a patient. Ventilation can be monitored with end-tidal carbon dioxide. The use of these tools together in a PCC environment provides estimates of oxygen transport to the cells, tissue metabolism, and adequacy of ventilation.
- Providers in the PCC environment can adopt, implement, monitor, and sustain respiration using concepts of manipulating minute ventilation (respiratory rate multiplied by tidal volume). Put simply, it is the number of times a patient is breathing each minute multiplied by the amount of air breathed in with each breath.
- Support of adequate minute ventilation can be performed in an escalating algorithm with rescue breathing, bag valve mask assisted ventilation, and mechanical ventilation. Each of these methods may require escalation of airway management skills and respiratory skills. Manipulation of any of the variables of minute ventilation will alter gas exchange. Therefore, medical providers in the PCC environment at all levels will need to be competent with the monitoring devices appropriate to their level of training. At a minimum, all providers with specific medical training should be competent to use and interpret the previous paragraph's monitoring devices.
- The causes of respiratory failure can overlap and become confusing. When in doubt and whenever possible, initiate a Telemedicine Consultation for further guidance and input.

CIRCULATION AND RESUSCITATION - PCC

Background

PCC presents a unique challenge for implementing damage control resuscitation (DCR) as defined by the JTS guideline. PCC goes beyond DCR and should bridge the gap between the prevention of death, the preservation of life, and definitive care. The goals are a return to a normal level of consciousness (LOC), increase and stabilization of systolic blood pressure at 100 - 110 mm Hg when appropriate, and stabilization of vital signs – Heart rate, respiratory rate, oxygen saturation, etc.

Table 5. PCC Level for Circulation and Resuscitation

<table>
<tr><th colspan="5">PCC Level for Circulation and Resuscitation</th></tr>
<tr><td rowspan="5">TCCC-ASM</td><td rowspan="4">TCCC-CLS</td><td rowspan="3">TCCC-CMC</td><td rowspan="3">TCCC-CPP</td><td>* All Personnel - Complete Basic TCCC Management Plan for Massive Hemorrhage then:
Role 1a
▪ Re-assess all tourniquets and wound dressings.
▪ Ensure that bleeding has stopped.
▪ If bleeding persists, consider additional tightening of the tourniquet, the use of an additional tourniquet, or the use of hemostatic dressings with wound packing to stem the hemorrhage.
▪ Conduct the principles of wound care to avoid infection and possible follow-on sepsis.
▪ Initiate hypothermia prevention measures.</td></tr>
<tr><td>Role 1b/1c
▪ Continue and/or initiate above circulation interventions.
▪ Initiate hypothermia prevention measures, if not already completed.</td></tr>
<tr><td>▪ Perform all recommended interventions from guidelines for above Tier level.
▪ Additional interventions include:
Role 1a
▪ Re-assess all tourniquets and wound dressings.
▪ Ensure that bleeding has stopped.
▪ If bleeding persists, consider additional tightening of the tourniquet, the use of an additional tourniquet or the use of hemostatic dressings with wound packing to stem the hemorrhage.
▪ Replace any limb tourniquet placed proximal over the uniform with one applied directly to the skin 2-3 inches above the wound.
▪ Assess extremities distal to pressure dressings.
▪ Check pulses and the skin color distal to the dressing.
▪ Decreased pulses or skin mottling may indicate the dressing is acting as a venous tourniquet.
▪ If present, dressing may need to be replaced or readjusted.
▪ Ongoing venous tourniquet could result in limb damage or development of compartment syndrome.
▪ Conduct the principles of wound care to avoid infection and possible follow-on sepsis.
▪ Initiate hypothermia prevention measures.</td></tr>
<tr><td>Role 1b/1c
▪ Continue and/or initiate above circulation interventions.
▪ Initiate hypothermia prevention measures, if not already completed.</td></tr>
<tr><td colspan="2">▪ Re-assess and re-apply MARCH interventions.
▪ Review transfusion transmitted disease (TTD)/titer of present unit members.
▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel</td></tr>
</table>

PCC Level for Circulation and Resuscitation

- Conduct inventory of all shock treatment supplies including whole blood, testing equipment, IVs, and other resources.
- Document all pertinent information on PCC Flowsheet (attached).
- Additional interventions include:

Role 1a

- Re-assess tourniquets and wound dressings as noted in above tier recommendations.
- Convert tourniquets per TCCC guidelines.
  - In less than 2 hours if bleeding can be controlled with other means.
  - DO NOT remove a tourniquet that has been in place more than 6 hours.
- Initiate hypothermia prevention measures.
- If present, assess pelvic compression device and verify placement and tightness.
- IV or intraosseous (IO) access if not already initiated in MARCH interventions:
  - If the casualty remains in hemorrhagic shock or at significant risk of shock.
  - If the casualty needs medications, but cannot take them by mouth.
- Initiate resuscitation with fluid replacement:
  - For casualties in hemorrhagic shock.
  - Give blood products per DCoT and TCCC guidelines.
  - Give calcium per TCCC guidelines.
  - If not already done, give TXA per TCCC guidelines.
  - Re-assess the casualty after each unit of blood and note on PCC FC vitals tracker.
- The goals of resuscitation:
  - Return to a normal LOC.
  - Return of palpable radial pulse
  - Continue resuscitation until:
    - **Minimum**: palpable radial pulse or improved mental status
    - **Better**: SBP > 90 mmHg
    - **Best**: SBP between 100-110 mmHg.
  - Stabilization of vital signs – Heart rate, respiratory rate, oxygen saturation.
- If the patient has signs of ongoing shock despite hemorrhage control:
  - Re-assess look for bleeding!
  - Consider alternate causes of shock – hypovolemic (burn, sepsis, diarrheal illness and other causes of non-hemorrhagic shock), obstructive (tension pneumothorax or cardiac tamponade), distributive (spinal cord injury, sepsis, anaphylaxis, etc.).
  - If shock is not hemorrhagic, then treat for alternate cause of shock: judicious crystalloid for sepsis and burns, chest tube for tension pneumothorax; crystalloid and vasopressors* for evidence of spinal cord injury with neurogenic shock.
- If resuscitation goals can all be met, maintain crystalloid IV or discontinue IV/IO resuscitation and have the casualty orally rehydrate (avoid free water due to risk of hyponatremia) until 0.3 – 0.5 mL/kg/hr. UOP is achieved.
- Initiate hypothermia prevention measures.
- Differentiate between transient responder, non-responder, and refractory shock.
- Communicate evacuation and re-supply requirements (i.e. blood resupply/speedball).

PCC Level for Circulation and Resuscitation	
Roles 1b/1c	▪ Continue and/or initiate above circulation and resuscitation interventions. ▪ Manage IV or IO access for ongoing resuscitation. ▪ Initiate hypothermia prevention measures. ▪ Differentiate between transient responder, non-responder, and refractory shock. ▪ Communicate evacuation and re-supply requirements (i.e. blood resupply/speedball). ▪ Initiate teleconsultation to medical control.
	▪ Re-assess and re-apply MARCH interventions. ▪ Review TTD/titer of present unit members. ▪ Ensure all interventions noted above are completed by TCCC ASM, CLS and CMC personnel ▪ Conduct inventory of all shock treatment supplies including whole blood, testing equipment, IVs, and other resources etc. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Role 1a** Interventions for both Tier 3 and Tier 4 level providers at this phase are the same.
Role 1b	▪ Ultrasound may be used to further refine the cause of ongoing hemorrhage or other causes of shock if available and medical provider is trained in its use. ▪ If ultrasound is available, teleconsultation can also be used to guide the provider in its implementation. ▪ Continually observe for changes in patient status, signs of clinical deterioration, alternate causes of shock, and need for change in resuscitation strategies. ▪ Continue resuscitation until: ・ **Minimum**: palpable radial pulse or improved mental status ・ **Better**: SBP > 90 mmHg ・ **Best**: SBP between 100-110 mmHg.
Role 1c	▪ Convert to type-specific blood replacement. ▪ Ultrasound may be used to further refine the cause of ongoing hemorrhage or other causes of shock if available and medical provider is trained in its use. ▪ If ultrasound is available, teleconsultation can also be used to guide the provider in its implementation. ▪ Continually observe for changes in patient status, signs of clinical deterioration, alternate causes of shock and need for change in resuscitation strategies. ▪ Continue resuscitation until: ・ **Minimum**: palpable radial pulse or improved mental status ・ **Better**: SBP > 90 mmHg ・ **Best**: SBP between 100-110 mmHg. ▪ If SBP remains less than 100-110 mmHg despite appropriate resuscitation and hemorrhage control, a vasopressor agent should be started if available*.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

** All use of pressors should be administered by role-based approved protocols or teleconsultation approval:*

- *norepinephrine continuous infusion 0.1–0.4 mcg/kg/min*
- *vasopressin continuous infusion 0.01-0.04 units*

COMMUNICATION AND DOCUMENTATION - PCC

Background

Communication and documentation in PCC are linked priorities as they are activities that are synergistic. For instance, the standard documentation forms (see below) that are used to track the important medical interventions and trends are the recommended scripts that are used in a teleconsultation. Effective documentation leads to effective communication, both in the immediate PCC environment and as a long-term medical management tool for the casualty.

Communication

- Communicate with the casualty if possible. Encourage, reassure, and explain care.
- Communicate with tactical leadership as soon as possible and throughout casualty treatment as needed. Provide leadership with casualty status and evacuation requirements to assist with coordination of evacuation assets.
- Verify evacuation request has been transmitted and establish communication with the evacuation platform as soon as tactically feasible relaying: mechanism of injury, injuries sustained, signs/symptoms, treatments rendered, and other information as appropriate. Have a rehearsed script to relay vital information to the next echelon of care prioritize interventions that cannot be seen by the next provider, such as medications.
- Ensure appropriate notification up the chain of command that PCC is being conducted; requesting support based on the MASCAL decision points.
- Call for teleconsultation as early and as often as needed (e.g., higher medical capability in the Chain of Command, the Advanced VIrtual Support for OpeRational Forces system line, etc.).
- Remember, communication of the situation and medical interventions that have been done and are ongoing includes both teleconsultation and the “handoff report.”

Documentation of Care

- There are 3 levels of documentation, categorized in a minimum, better, best format:
  - Minimum - Documentation of care on the TCCC card (DD1380).
  - Better - Utilization of a standard PCC flowsheet (if available), example attached.
  - Best - Completion of a formal After Action Report (AAR) after patient handoff.
- Transfer documented clinical assessments and treatments rendered. If the availably to scan and/or transmit this information to all parties involved teleconsultation (using all approved and available means), do so for them to have as much of the information as possible.
- Perform a detailed head-to-toe assessment and record all findings as a problem list so that a comprehensive care plan can then be constructed using the attached flow sheet.

Table 6. PCC Role-based Guidelines for Communications and Documentation

PCC Role-based Guidelines for Communication and Documentation				
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	*Complete Basic TCCC Communication and Documentation Principles then:* ▪ Identify requirements for communicating care to the casualty, leadership, and medical personnel in accordance with TCCC Guidelines. ▪ Document casualty information on the DD Form 1380 TCCC Card and ensure proper placement of that card on the casualty, in accordance with DHA-PI 6040.01. ▪ Initiate scripted teleconsultation.
				▪ Monitor the documentation for each casualty and ensure that it is completed by those service members assisting with care. ▪ Initiate scripted teleconsultation.
				Ensure documentation and communication is completed for each casualty in accordance with PCC standards: ▪ Ensure that communication is established with evacuation assets and/or receiving facilities. ▪ Prepare evacuation request and set up priorities for evacuation for each casualty. ▪ Ensure DD1380 TCCC Cards are completed for every casualty. ▪ Initiate scripted teleconsultation. ▪ Complete AAR.
				Ensure documentation and communication is completed for each casualty in accordance with PCC standards: ▪ Ensure communication is established with evacuation assets and/or receiving facilities. ▪ Initiate scripted teleconsultation, if needed. ▪ Prepare evacuation request and set up priorities for evacuation for each casualty. ▪ Ensure DD1380 TCCC Cards are completed for every casualty. ▪ Complete After Action Report with an emphasis on the scenario's impact on future unit-level medical training and logistics requirements.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

*Link to Documentation in Prolonged Field Care, 13 Nov 2018 CPG [10]

* Link to Documentation Requirements for Combat Casualty Care, 18 Sep 2020 CPG [11]

HYPOTHERMIA - PCC

Background

Prevention of hypothermia must be emphasized in combat operations and casualty management at all levels of care. Hypothermia occurs regardless of the ambient temperature; hypothermia can, and does, occur in both hot and cold climates. Because of the difficulty, time, and energy required to actively re-warm casualties, significant attention must be paid to preventing hypothermia from occurring in the first place. Prevention of hypothermia is much easier than treatment of hypothermia; therefore prevention of heat loss should start as soon as possible after the injury. This is optimally accomplished in a layered fashion with rugged, lightweight, durable products that are located as close as possible to the point of injury, and then utilized at all subsequent levels of care, including ground and air evacuation, through all levels of care.[12]

Table 7. PCC Role-based Guidance for Hypothermia Management

PCC Role-based Guidance for Hypothermia Management					
TCCC-ASM	**TCCC-CLS**	**TCCC-CMC**	**TCCC-CPP**		
				Complete Basic TCCC Management Plan for Hypothermia then:	
				Role 1a	▪ Take early and aggressive steps to prevent further body heat loss and add external heat when possible for both trauma and severely burned casualties. ▪ Minimize casualty's exposure to cold ground, wind and air temperatures. Place insulation material between the casualty and any cold surface as soon as possible. ▪ Keep protective gear on or with the casualty, if feasible. ▪ Replace wet clothing with dry clothing, if possible, and protect from further heat loss. If unable to replace the dry clothing, wrap an impermeable layer around the casualty. ▪ Place an active heating blanket on the casualty's anterior torso and under the arms in the axillae. ▪ **Caution**: DO NOT place any active external heating directly on the skin or in areas of skin which are under pressure or have poor blood flow as this increases risk of injury and/or skin burns. ▪ Enclose the casualty with the exterior impermeable enclosure bag, if available. ▪ Protect the casualty from exposure to wind and precipitation on any evacuation platform.
				Role 1b	▪ Continue and/or initiate above hypothermia interventions. ▪ Pre-stage an insulated hypothermia enclosure system with external active heating for transition from the non-insulated hypothermia enclosure systems; seek to improve upon existing enclosure system when possible. ▪ Upgrade hypothermia enclosure system to a well-insulated enclosure system using a hooded sleeping bag or other readily available insulation inside the enclosure bag/external vapor barrier shell. ▪ **Best**: Improvised hypothermia wrap with high-quality insulation with cold-rated sleeping bag combined with heat source, internal vapor barrier, outer impermeable enclosure. ▪ When using the Hypothermia Prevention and Management Kit (HPMK) ready-heat-blanket, perform frequent skin checks to monitor for contact burns. ▪ Protect the casualty from exposure to wind and precipitation on any evacuation platform.

PCC Role-based Guidance for Hypothermia Management
Role 1c ▪ Continue and/or initiate the Role 1a/Role 1b phases as detailed above. ▪ Replace ready-heat-blanket when using >10 hours.
▪ Perform all recommended interventions from guidelines for above Tier level ▪ Additional interventions include: **Role 1a** Communicate re-supply requirements.
Role 1b Protect the casualty from exposure to wind and precipitation on any evacuation platform.
Role 1c ▪ Continue and/or initiate the Role 1a/Role 1b phases as detailed above ▪ Replace ready-heat-blanket when using >10 hours.
▪ Interventions for both CMC and CPP are the same. ▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include: **Role 1a** ▪ Use a battery-powered warming device to deliver IV resuscitation fluids, in accordance with current TCCC guidelines, at flow rate up to 150 ml/min with a 38°C output temperature. ▪ Communicate re-supply requirements.
Role 1b ▪ Convert to continuous temperature monitoring. ▪ **Minimum**: Scheduled temperature measurement with vital sign evaluations. ▪ **Better**: Continuous forehead dot monitoring. ▪ **Best**: Continuous core temperature monitoring. ▪ Protect the casualty from exposure to wind and precipitation on any evacuation platform.
Role 1c ▪ Continue and/or initiate the Role 1a/Role 1b phases as detailed above. ▪ Replace ready-heat-blanket when using >10 hours.
Interventions for both CMC and CPP are the same.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

*Link to Hypothermia Prevention, Monitoring and Management, 18 Sep 2012 CPG [12]

HYPERTHERMIA - PCC

Background

1. Hyperpyrexia is elevated body temperature.
2. Fever is elevated body temperature in response to a change in hypothalamic set point (infections).
3. Hyperthermia is elevated body temperature without a change in hypothalamic set point (heat illness, hyperthyroid, drugs).
4. The Second Law of Thermodynamics states that heat flows from hot to cold.
5. Heat transfer can occur through several processes:
    a. Radiation
    b. Conduction
    c. Convection
    d. Evaporation

Heat exhaustion

Symptoms: weak, dizzy, nauseated, headache, sweating, normal mental status. Heat exhaustion requires replacement of fluids and electrolytes.

Heat stroke

Symptoms: Hyperthermia + mental status changes. Heat stroke requires immediate cooling.

Table 8. PCC Role-based Guideline for Hyperthermia Management

PCC Role-based Guidance for Hyperthermia Management				
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	***Complete Basic TCCC Management Plan for Hyperthermia then:***
				Role 1a ▪ Move the casualty to the shade if possible. ▪ Insulate the casualty from the ground (conduction). ▪ Remove the casualty from a vehicle (radiation). ▪ If situation allows, remove the casualty's helmet and vest (evaporation). ▪ Fan the casualty (convection). ▪ If the casualty is conscious and not vomiting, give liquids. ▪ Protect the casualty from exposure to sources of heat if possible. ▪ DO NOT give acetaminophen, aspirin or ibuprofen for hyperthermia, only for fever. ▪ Prevent heat illness/injury in casualties by maintaining hydration, adding salt to food, resting in shade, staying off hot surfaces (ground or vehicle), removing tactical gear when possible.
				Role 1b Continue and/or initiate above hyperthermia interventions.
				Role 1c Continue and/or initiate the Role 1a/Role 1b phases as detailed above.
				▪ Perform all recommended interventions from guidelines for above tier level ▪ Additional interventions include:

PCC Role-based Guidance for Hyperthermia Management	
Role 1a	▪ If the casualty is unconscious or vomiting, use IV/IO fluids. ▪ Communicate re-supply requirements.
Role 1b	Continue and/or initiate above hyperthermia interventions.
Role 1c	Continue and/or initiate the Role 1a/Role 1b phases as detailed above.
	▪ Interventions for both CMC and CPP providers are the same. ▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include:

Role 1a	▪ If the casualty is unconscious or vomiting, use IV/IO fluids.
	▪ Monitor for signs and symptoms of heat exhaustion - if present: Immediately replace fluids and electrolytes.
	▪ Monitor for signs and symptoms of heat stroke - if present:
	  ▪ Immediate cooling must be initiated.
	  ▪ **Minimum**: Wetting clothing.
	  ▪ **Better**: Fanning the casualty after wetting clothing.
	  ▪ **Best**: Immersion in water.
	▪ Casualties should eat, if possible, to prevent sodium loss, which may lead to dilutional hyponatremia (low sodium).
	▪ Dilutional hyponatremia may look like heat illness, but is due to drinking and not eating.
	▪ Seizures should be treated with benzodiazepines.
	▪ Communicate re-supply requirements.

Role 1b	▪ Convert to continuous temperature monitoring.
	  ▪ **Minimum**: Scheduled temperature measurement with vital sign evaluations.
	  ▪ **Better**: Continuous forehead dot monitoring.
	  ▪ **Best**: Continuous core temperature monitoring.
	▪ Prevent heat illness/injury in casualties by maintaining hydration, adding salt to food, resting in shade, staying off hot surfaces (ground or vehicle), removing tactical gear when possible.

Role 1c	▪ Continue and/or initiate the Role 1a/Role 1b phases as detailed above.
	Interventions for both CMC and CPP are the same.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

HEAD INJURY/TBI - PCC

Background

TBI occurs when external mechanical forces impact the head and cause an acceleration/deceleration of the brain within the cranial vault which results in injury to brain tissue. TBI may be closed (blunt or blast trauma) or open (penetrating trauma).[13] Signs and symptoms of TBI are highly variable and depend on the specific areas of the brain affected and the injury severity. Alteration in consciousness and focal neurologic deficits are common. Various forms of intracranial hemorrhage, such as epidural hematoma, subdural hematoma, subarachnoid hemorrhage, and hemorrhagic contusion can be components of TBI. The vast majority of TBIs are categorized as mild and are not considered life threatening; however, it is important to recognize this injury because if a patient is exposed to a second head injury while still recovering from a mild TBI, they are at risk for increased long-term cognitive effects. Moderate and severe TBIs are life-threatening injuries.

Pre-deployment, Mission Planning, and Training Considerations

1. Conduct unit level TTD/Titer testing and develop an operational roster.
2. Conduct baseline neurocognitive assessment per Service guideline.
3. When possible and practical, keep patient in an elevated orientation to approximately 30 degrees while maintaining C-spine precautions (as clinically indicated) and airway control (don't just elevate the head by bending the neck).
4. Define CSWB distribution quantities in area of responsibility.
5. Determine feasibility and requirement for pre-deployment unit level blood draw.
6. Conduct unit level pre-deployment blood draw as required.
7. Ensure critical head-injury adjunct medications appropriately stocked and storage requirements met.

Treatment Guidelines

Table 9. PCC Role-based Guideline for Head Injury/TBI Management

PCC Role-based Guidance for Head Injury/TBI Management				
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	***Complete Basic TCCC Management Plan for Heat Injury/TBI then:***
				Role 1a ▪ Identification and local wound management of any open head wounds/skull fractures. Priorities should include hemorrhage control, removal of gross contamination, and protection/coverage of any exposed dura or brain matter. ▪ Military Acute Concussive Evaluation 2 (MACE2) (*See Appendix E) examination per DoD/TCCC guideline. ▪ Communicate evacuation requirements (need for TBI evaluation, neurosurgery) ▪ Communicate re-supply requirements.
				Role 1b/1c ▪ Re-assess and re-apply MARCH interventions. ▪ Serial neurologic checks, including pupil exam and identify signs of elevated or rising intracranial pressure (Appendix E) - at least hourly. ▪ Identify catastrophic/non-survivable brain injury. ▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for any patient with initial mild TBI who deteriorates to moderate/severe TBI category.
				▪ Re-assess and re-apply MARCH interventions. ▪ Conduct inventory of all treatment supplies. ▪ Document all pertinent information on PCC Flowsheet (attached).
				Role 1a ▪ Identification and local wound management of open head wounds/skull fractures. Priorities should include hemorrhage control, removal of gross contamination, and protection/coverage of any exposed dura or brain matter. ▪ MACE2 examination per TCCC guideline. ▪ Communicate evacuation requirements (need for TBI evaluation, neurosurgery). ▪ Communicate re-supply requirements.
				Role 1b/1c ▪ Re-assess and re-apply MARCH interventions. ▪ Serial neurologic checks and identify signs of elevated or rising intracranial pressure (Appendix E). ▪ Administer appropriate antibiotics for any open head wounds or skull fracture (see antibiotics section). ▪ Identify the critical observations that should be reported to medical personnel for trauma casualties with a suspected head injury, in accordance with the MACE2. ▪ Teleconsultation with trauma surgeon and/or neurosurgeon as available. ▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for any patient with initial mild TBI who deteriorates to moderate/severe TBI category.
				▪ Re-assess and re-apply MARCH interventions. ▪ Ensure all interventions noted above are completed by non-medical TCCC ASM and CLS personnel and CLS-trained service members. ▪ Conduct inventory of all treatment supplies. ▪ Document all pertinent information on PCC Flowsheet (attached).
				Role 1a ▪ Identification and local wound management of any open head wounds/skull fractures. Priorities should include hemorrhage control, removal of gross contamination, and protection/coverage of any exposed dura or brain matter.

PCC Role-based Guidance for Head Injury/TBI Management	
	▪ Identify signs of elevated or rising intracranial pressure (ICP) per Appendix E. Initiate immediate treatment for signs of elevated ICP including initial bolus of 3% hypertonic saline (HTS) 250-500 ml if available. Alterative: 23.4% sodium chloride. ▪ Administer TXA as single 2gram IV or IO bolus (no second dose required). ▪ Communicate evacuation requirements (need for TBI evaluation, neurosurgery). ▪ Communicate re-supply requirements.

Role 1b	▪ Re-assess and re-apply MARCH interventions.
	▪ Administer appropriate antibiotics for any open head wounds or skull fracture (see antibiotics section).
	▪ Maintain goal SBP >90 mmHg with initial fluid/blood product resuscitation.
	▪ Serial neurologic checks and identify signs of elevated or rising intracranial pressure (Appendix E); If noted, the following interventions are recommended, if possible:
	  ▪ HTS administration (intermittent bolus versus continuous infusion) per Appendix E. Alterative: 23.4% sodium chloride.
	  ▪ Supplemental oxygen to maintain O2 sats > 94% and <99%, ETCO2 if intubated with goal of mild hyperventilation to 35-40.
	  ▪ Brief (less than 30 minutes) moderate hyperventilation to goal pCO2/ETCO2 20-30 may be performed for signs of impending/active herniation (pupil becomes fixed and dilated); if there is a neurosurgical capability.
	  ▪ ** Note: Use hyperventilation only as a temporizing measure while additional ICP treatments are being administered or tactical evacuation is in process.
	▪ Repeat primary and secondary survey for any abrupt decline in the Glasgow Coma Scale (GCS) or change in pupil exam to rule out non-neurologic causes.
	▪ Minimize analgesia and sedation agents, and avoid paralyses, if possible, to preserve ability to obtain neurologic exam, but medical and operational considerations should take priority if deeper sedation or paralysis required.
	▪ Teleconsultation with Trauma Surgeon and/or Neurosurgeon as available.
	▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for any patient with initial mild TBI who deteriorates to moderate/severe TBI category.
	▪ Repeat triage evaluation and identification of likely non-survivable condition (or associated injuries) based on injury types/severity and required vs available resources.

Role 1c	▪ Continue serial neurologic checks including GCS and pupil exam at least hourly. ▪ Immediate seizure treatment with benzodiazepines, consider ketamine for refractory seizures. ▪ Temperature management and aggressive fever control. ▪ Teleconsultation with trauma surgeon and/or neurosurgeon as available. ▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for any patient with initial mild TBI who deteriorates to moderate/severe TBI.
	▪ Re-assess and Re-apply MARCH interventions. ▪ Ensure all basic nursing interventions noted above are completed by non-medical TCCC ASM and CLS personnel, CLS-trained service members and medics/corpsmen. ▪ Conduct inventory of all treatment supplies. ▪ Document all pertinent information on PCC Flowsheet (attached).
Role 1a	▪ Identification and local wound management of any open head wounds/skull fractures. Priorities should include hemorrhage control, removal of gross contamination, and protection/coverage of any exposed dura or brain matter. ▪ MACE2 examination per TCCC guideline. ▪ Serial GCS exams (Appendix E.) ▪ Identify signs of elevated or rising ICP per Appendix E.

PCC Role-based Guidance for Head Injury/TBI Management	
	▪ Initiate immediate treatment for signs of elevated ICP including initial bolus of 3% hypertonic saline (HTS) 250-500 ml. Alterative: 23.4% sodium chloride. ▪ Administer TXA as single 2gram IV or IO bolus (no second dose required). ▪ Communicate evacuation requirements (need for TBI evaluation, neurosurgery). ▪ Communicate re-supply requirements.

Role 1b	▪ Re-assess and re-apply MARCH interventions.
	▪ Administer antibiotics for any open head wounds or skull fracture. (See Antibiotics). Continue resuscitation until:
	  ▪ **Minimum**: palpable radial pulse or improved mental status
	  ▪ **Better**: SBP > 90 mmHg
	  ▪ **Best**: SBP between 100-110 mmHg
	  ▪ If SBP remains less than 100-110 mmHg despite appropriate resuscitation and hemorrhage control, a vasopressor agent should be started if available.
	  ▪ norepinephrine continuous infusion 0.1–0.4 mcg/kg/min
	  ▪ vasopressin continuous infusion 0.01-0.04 units
	** All use of pressers should be administered by role-based approved protocols or teleconsultation approval*
	▪ Serial neurologic checks and identify signs of elevated or rising intracranial pressure (Appendix E); If noted, the following interventions are recommended, if possible:
	  ▪ HTS administration (intermittent bolus versus continuous infusion) per Appendix E. Alternative: 23.4% sodium chloride.
	  ▪ Administer seizure prophylaxis (1G Levetiracetam), if available.
	  ▪ Supplemental oxygen to maintain O2 sats > 94%, ETCO2 if intubated with goal of norocapnia with pCO2 of 35-40.
	  ▪ Brief (less than 30 min) moderate hyperventilation to goal pCO2/ETCO2 20-30 may be performed for signs of impending/active herniation (pupil becomes fixed and dilated).
	  ▪ ** **Note**: Use hyperventilation only as a temporizing measure while additional ICP treatments are being administered or tactical evacuation is in process.
	▪ Repeat primary and secondary survey for any abrupt decline in the GCS or change in pupil exam to rule out non-neurologic causes.
	▪ Minimize analgesia and sedation agents, if possible, to preserve ability to obtain neurologic exam, but medical and operational considerations should take priority if deeper sedation or paralysis required.
	▪ Teleconsultation with trauma surgeon and/or neurosurgeon as available.
	▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for patients with initial mild TBI who deteriorates to moderate/severe TBI category.
	▪ Repeat triage evaluation and identification of non-survivable condition (or associated injuries) based on injury types/severity and required vs available resources.

Role 1c	▪ Continue serial neurologic checks including GCS and pupil exam at least hourly. ▪ Immediate seizure treatment with benzodiazepines, consider ketamine for refractory seizures. ▪ Temperature management and aggressive fever control. ▪ Teleconsultation with trauma surgeon and/or neurosurgeon as available. ▪ Upgrade evacuation priority and destination (facility with neurosurgical capabilities) for patients with initial mild TBI who deteriorates to moderate/severe TBI category.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

See Appendix E for additional TBI resources.

*Link to Traumatic Brain Injury in Prolonged Field Care, 6 December 2017 CPG [14]

PAIN MANAGEMENT (ANALGESIA AND SEDATION) FOR PCC

Background

A provider of PCC must first and foremost be an expert in TCCC and then be able to identify all the potential issues associated with providing analgesia with or without sedation for a prolonged (4-48 hr.) period.

These PCC pain management guidelines are intended to be used after TCCC Guidelines at the Role 1 setting, when evacuation to higher level of care is not immediately possible. They attempt to decrease complexity by minimizing options for monitoring, medications, and the like, while prioritizing experience with a limited number of options versus recommending many different options for a more customized fashion. Furthermore, it does not address induction of anesthesia before airway management (i.e. rapid sequence intubation).

Remember, YOU CAN ALWAYS GIVE MORE, but it is very difficult to take away. Therefore, it is easier to prevent cardiorespiratory depression by being patient and methodical. TITRATE TO EFFECT.

Priorities of Care Related to Analgesia and Sedation

1. Keep the casualty alive. DO NOT give analgesia and/or sedation if there are other priorities of care (e.g., hemorrhage control).
2. Sustain adequate physiology to maintain perfusion. DO NOT give medications that lower blood pressure or suppress respiration if the patient is in shock or respiratory distress (or is at significant risk of developing either condition).
3. Manage pain appropriately (based on the pain categories below).
4. Maintain safety. Agitation and anxiety may cause patients to do unwanted things (e.g., remove devices, fight, fall). Sedation may be needed to maintain patient safety and/or operational control of the environment (i.e. in the back of an evacuation platform).
5. Stop awareness. During painful procedures, and during some mission requirements, amnesia may be desired. If appropriate, disarm or clear their weapons and prevent access to munitions/ mission essential communications.

General Principles

- Consider pain in three categories:
    1. Background: the pain that is present because of an injury or wound. This should be managed to keep a patient comfortable at rest but should not impair breathing, circulation, or mental status.
    2. Breakthrough: the acute pain induced with movement or manipulation. This should be managed as needed. If breakthrough pain occurs often or while at rest, pain medication should be increased in dose or frequency as clinically prudent but within the limits of safety for each medication.
    3. Procedural: the acute pain associated with a procedure. This should be anticipated and a plan for dealing with it should be considered.

- Analgesia is the alleviation of pain and should be the primary focus of using these medications (treat pain before considering sedation). However, not every patient requires (or should receive) analgesic medication at first, and unstable patients may require other therapies or resuscitation before the administration of pain or sedation medications.
- Sedation is used to relieve agitation or anxiety and, in some cases, induce amnesia. The most common causes of agitation are untreated pain or other serious physiologic problems like hypoxia, hypotension, or hypoglycemia. Sedation is used most commonly to ensure patient safety (e.g., when agitation is not controlled by analgesia and there is need for the patient to remain calm to avoid movement that might cause unintentional tube, line, dressing, splint, or other device removal or to allow a procedure to be performed) or to obtain patient amnesia to an event (e.g., forming no memory of a painful procedure or during paralysis for ventilator management).
- In a Role 1 (or PCC) setting, intravenous (IV) or interosseous (IO) medication delivery is preferred over intramuscular (IM) therapies. The IV/IO route is more predictable in terms of dose-response relationship.
- Each patient responds differently to medications, particularly with respect to dose. Some individuals require substantially more opioid, benzodiazepine, or ketamine; some require significantly less. Once you have a "feel" for how much medication a patient requires, you can be more comfortable giving it to patient with a broad range of injuries.
- Similar amounts during redosing. In general, a single medication will achieve its desired effect if enough is given; however, the higher the dose, the more likely the side effects.
- Additionally, ketamine, opioids, and benzodiazepines given together have a synergistic effect: the effect of medications given together is much greater than a single medication given alone (i.e., the effect is multiplied, not added, so go with less than what you might normally use if each were given alone).
- Pain medications should be given when feasible after injury or as soon as possible after the management of MARCH and appropriately documented (medication administered, dose, route and time). Factors for delayed pain management (other than Combat Pill Pack) are need for individual to maintain a weapon/security and inability to disarm the patient.
- PCC requires a different treatment approach than TCCC. Go slowly, use lower doses of medication, titrate to effect, and re-dose more frequently. This will provide more consistent pain control and sedation. High doses may result in dramatic swings between over sedation with respiratory suppression and hypotension alternating with agitation and emergence phenomenon.

Drips and Infusions

For IV/IO drip medications: Use normal saline to mix medication drips when possible, but other crystalloids (e.g., lactated Ringer's, Plasmalyte, and so forth) may be used if normal saline is not available. DO NOT mix more than one medication in the same bag of crystalloid. Mixing medications together, even for a relatively short time, may cause changes to the chemical structure of one or both medications and could lead to toxic compounds.

If a continuous drip is selected, use only a ketamine drip in most situations, augmented by push doses of opioid and/or midazolam if needed. Multiple drips are difficult to manage and should only be undertaken with assistance from a Teleconsultation with critical care experience. Multiple drips are

most likely to be helpful in patients who remain difficult to sedate with ketamine drip alone and can "smooth out" the sedation (e.g., fewer peaks and troughs of sedation with corresponding deep sedation mixed with periods of acute agitation).

Other medications that should be available when providing narcotic pain control is Naloxone. If the patient receives too much medication, consider dilution of 0.4mg of naloxone in 9ml saline (40mcg/mL) and administer 40mcg IV/IO PRN to increase respiratory rate, but still maintaining pain control.

The PCC Pain Management Guideline Tables

These tables are intended to be a quick reference guide but are not standalone: you must know the information in the rest of the guideline. The tables are arranged according to anticipated clinical conditions, corresponding goals of care, and the capabilities needed to provide effective analgesia and sedation according to the minimum standard, a better option when mission and equipment support (all medics should be trained to this standard), and the best option that may only be available in the event a medic has had additional training, experience, and/or available equipment.

Medications in the table are presented as either give or consider:

- **Give**: Strongly recommended.
- **Consider**: Requires a complete assessment of patient condition, environment, risks, benefits, equipment, and provider training.

Use these steps when referencing the tables:

Step 1. Identify the clinical condition

- Standard analgesia is for most patients. The therapies used here are the foundation for pain management during PCC. Expertise in dosing fentanyl (OTFC or IV) and ketamine IV or IO is a must. Intramuscular and intranasal dosing of medications isn't recommended in a PCC setting.
- Difficult analgesia or sedation needed is for patients in whom standard analgesia does not achieve adequate pain control without suppressing respiratory drive or causing hypotension, OR when mission requirements necessitate sedating a patient to gain control over their actions to achieve patient safety, quietness, or necessary positioning.
- Protected airway with mechanical ventilation is for patients who have a protected airway and are receiving mechanical ventilatory support or are receiving full respiratory support via assisted ventilation (i.e. bag valve).
- Shock present is for patients who have hypotension, active hemorrhage, and/or tachycardia.

Step 2. Read down the column to the row representing your available resources and training.

Step 3. Provide analgesia/sedation medication accordingly.

Step 4. Consider using the Richmond Agitation-Sedation Scale (RASS) score (Appendix E) as a method to trend the patient's sedation level.

Table 10. PCC Role-based Guideline for Pain Management (Analgesia and Sedation)

PCC Role-based Guideline for Pain Management (Analgesia and Sedation)

TCCC-ASM | TCCC-CLS | TCCC-CMC | TCCC-CPP

Complete Basic TCCC Communication Plan for Pain Management then:

- Administer meloxicam and acetaminophen (pain medications in Joint First Aid Kit [JFAK]) per TCCC guidelines if not already given.
- Identify painful conditions that can be treated without the use of medications.
  - Fractures - apply splint per TCCC guidelines.
  - Exposed burns - burn care per TCCC guidelines.
  - Tourniquets will cause significant pain - DO NOT remove a tourniquet in an attempt to alleviate pain unless directed to do so by a higher medical authority.

Drug/Interactions/Dose	Onset	Duration	Side Effects
Acetaminophen ▪ Mild-moderate pain, able to fight ▪ Use with meloxicam ▪ 1 gram every 6 hours	<1 hr when given by mouth	4-6 hours	▪ Allergic Reaction (rare) ▪ Liver damage: limit daily dose of acetaminophen and acetaminophen-containing products (e.g., Percocet) to 4,000mg/day
Meloxicam ▪ Mild-moderate pain, able to fight ▪ Use with acetaminophen ▪ 15 mg daily	<1 hr when given by mouth	24 hours	▪ Reflux ▪ Abdominal pain ▪ Nausea/vomiting ▪ Diarrhea and/or constipation

Administer meloxicam and acetaminophen (in JFAK) per TCCC guidelines if not already given.

- Pain medications should be given when feasible after injury or as soon as possible after the management of MARCH and appropriately documented (medication administered, dose, route and time).
- Pain meds initiated in TCCC can often be continued in the PCC environment for both ongoing analgesia and sedation, as long as the duration and cumulative side effects are well understood and mitigated.

Drug/Interactions/Dose	Onset	Duration	Side Effects
OTFC (Oral Transmucosal Fentanyl Citrate) ▪ Moderate to severe pain, unable to fight without hemorrhagic shock or respiratory distress ▪ 800 mcg every 30 min	5 mins when given by mouth	20-40 minutes	▪ Respiratory/cardiac/mental status depression ▪ Nausea/vomiting ▪ Pruritus (itching) ▪ Constipation
Ketamine ▪ Moderate to severe pain, unable to fight with hemorrhagic shock or respiratory distress ▪ 30 mg (or 0.3 mg/kg) slow IV or IO push every 20 min ▪ May repeat ▪ Ketamine 50-100 mg (or 0.5-1 mg/kg) IM or IN every 20-30 min	30 secs IV or 1-5 mins IM	10-15 mins IV or 20-30 mins IM	▪ Cataleptic-like state (dissociated from the surrounding environment) ▪ Respiratory depression at higher doses (>1mg/kg), especially with fast administration IV/IO ▪ Hypersalivation (can be problematic in an austere setting) ▪ Increased blood pressure and heart rate. ▪ Nausea/vomiting

PCC Role-based Guideline for Pain Management (Analgesia and Sedation)			
▪ May repeat **For Sedation** ▪ 1-2 mg/kg slow IV push initial dose ▪ 300 mg IM (or 2-3 mg/kg IM) initial dose ▪ May repeat			
Ondansetron (Zofran) ▪ For nausea/vomiting ▪ 1-2 tabs PO/SL every 4-6 hours PRN ▪ 4 mg IV, may repeat 1 time in 2 hours if N/V returns	30 min - hr when given PO or SL, 5-10 mins when given IV	3-6 hours	▪ Drowsiness ▪ Fatigue ▪ Anxiety
Naloxone (Narcan) ▪ For complete or partial reversal of opioid depression (respiratory/cardiac/mental) ▪ 0.4-2 mg IV/IM/IO ▪ May repeat every 2-3 minutes (MAX dose 10 mg)	1-2 minutes IV or 2–5 minutes IM/IO	30-90 mins Note: some opioids have longer duration so naloxone may need to be repeated	▪ Abrupt withdrawal reaction from opioid depression should be anticipated and preparations should be made. ▪ This reaction may include vomiting, sweating, tachycardia, increased blood pressure, agitation.
▪ Pain medications should be given when feasible after injury or as soon as possible after the management of MARCH and appropriately documented (medication administered, dose, route and time). ▪ Pain meds that are initiated in TCCC can often be continued in the PCC environment for both ongoing analgesia and sedation, as long as the duration and cumulative side effects are well understood and mitigated.			
Drug/Interactions/Dose	Onset	Duration	Side Effects
Fentanyl ▪ Moderate to severe pain, unable to fight without hemorrhagic shock or respiratory distress ▪ 50 mcg IV (0.5-1 mcg/kg) or 100 mcg IN, may repeat every 1-2 hours	1-2 minutes when given IV	30-60 minutes	▪ Respiratory/cardiac/ mental status depression ▪ Nausea/vomiting ▪ Pruritus (itching) ▪ Constipation
Ketamine ▪ Moderate to severe pain, unable to fight with hemorrhagic shock or respiratory distress ▪ 30 mg (or 0.3 mg/kg) slow IV or IO push every 20min ▪ May repeat ▪ Ketamine 50-100 mg (or 0.5-1 mg/kg) IM or IN every 20-30 min	30 secs IV or 1–5 mins IM	10–15 mins IV or 20–30 mins IM	▪ Cataleptic-like state (dissociated from the surrounding environment) ▪ Respiratory depression at higher doses (>1mg/kg), especially with fast administration IV/IO ▪ Hypersalivation (can be problematic in an austere setting) ▪ Increased blood pressure and heart rate. ▪ Nausea/vomiting

PCC Role-based Guideline for Pain Management (Analgesia and Sedation)			
▪ May repeat **For sedation** ▪ 1-2 mg/kg slow IV push initial dose ▪ 300 mg IM (or 2-3 mg/kg IM) initial dose **For longer duration analgesia** ▪ Slow IV infusion 0.3 mg/kg in 100 ml 0.9% sodium chloride over 5-15 minutes every 45 minutes prn for IV or IO			
▪ When available and applicable, other medications can be considered. ▪ These medications should be used based on local protocols and policies put in place by your medical director or through direct teleconsultation guidance.			
Drug/Interactions/Dose	Onset	Duration	Side Effects
Midazolam (Versed) ▪ For sedation and anxiolysis; will also cause anterograde amnesia ▪ 2-4 mg IM ▪ 0.5-1mg IV (push slowly over 1-2 minutes)	15-20 mins when given IM, 2 mins when given IV	1-6 hrs when given IM, 15 min-6 hrs (HIGH variability)	▪ Drowsiness ▪ Respiratory depression ESPECIALLY when used with any narcotic ▪ Nausea/vomiting
Acetaminophen/Hydrocodone (Norco) ▪ For moderate-severe pain ▪ Comes in multiple strengths of hydrocodone - 5/7.5.10 mg ▪ 1-2 tabs PO every 4-6 hours PRN for 5mg hydrocodone strength	10-20 minutes	3-4 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation ▪ Nausea/vomiting ▪ Itching Note: contains acetaminophen. Be aware of total dose when given with other drugs that contain acetaminophen
Acetaminophen/Oxycodone (Percocet) ▪ For moderate-severe pain ▪ Comes in multiple strengths of oxycodone - 5/7.5/10 mg ▪ 1-2 tabs PO every 4-6 hours PRN for 5mg oxycodone dose	10-20 minutes	3-4 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation ▪ Nausea/vomiting ▪ Itching Note: contains acetaminophen. Be aware of total dose when given with other drugs that contain acetaminophen
Hydromorphone (Dilaudid) ▪ For severe pain ▪ 1-2 mg IM ▪ 0.5 - 1 mg IV	15-20 mins when given IM, 2 mins when given IV	3-4 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation ▪ Nausea/vomiting ▪ Itching
Morphine ▪ For severe pain ▪ 5-10 mg IM	15-20 mins when given IM, 2-5	3-4 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation

PCC Role-based Guideline for Pain Management (Analgesia and Sedation)				
	▪ 2 - 4 mg IV	mins when given IV		▪ Nausea/vomiting ▪ Itching
	Tramadol (**Ultram**) ▪ For moderate-severe pain ▪ 1-2 tabs PO every 4-6 hours PRN (DO NOT exceed 400 mg tramadol/day)	10-20 minutes	4-6 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation ▪ Nausea/vomiting ▪ CNS stimulation including seizures at high doses ▪ Note: Some preparations (i.e., Ultram) contain acetaminophen. Be aware of total dose when given with other drugs that contain acetaminophen.
	Codeine/acetaminophen ▪ For moderate-severe pain ▪ 1-2 tabs PO every 4-6 hours PRN (for tabs with 15mg Codeine)	30 minutes - 1 hour	4-6 hours	▪ Drowsiness ▪ Respiratory depression ▪ Sedation ▪ Nausea/vomiting ▪ Itching ▪ Note: Contains acetaminophen. Be aware of total dose when given with other drugs that contain acetaminophen.
	▪ In some cases, local anesthetics or even limited regional anesthesia is the best option for pain control (For more information, see Military Analgesia Regional Anesthesia Guidelines.) ▪ While side effects are real and toxic levels of these drugs must be understood and avoided, the benefit can often be achieved without sedation when appropriate for the tactical environment.			

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

Special Considerations

Patient Monitoring During Sedation

Patients receiving analgesia and sedation require close monitoring for life-threatening side-effects of medications.

- **Minimum**: Blood pressure cuff, stethoscope, pulse oximeter; document vital signs trends.
- **Better**: Capnography in addition to minimum requirements
- **Best**: Portable monitor providing continuous vital signs display and capnography; document vital signs trends frequently.

Analgesia and Sedation for Expectant Care (i.e. End-of-Life Care)

An unfortunate reality of our profession, both military and medical, is that we encounter clinical scenarios that will inevitably end in a patient's death. In these situations, it is a healthcare provider's obligation to give palliative therapy to minimize the person's suffering. In these circumstances, the use of opioid analgesics and sedative medications is therapeutic and indicated, even if these medications worsen a patient's vital signs (i.e., cause respiratory depression and/or hypotension). If a patient is expectant:

- Teleconsultation
- Prepare to:
  - Give opioid until the patient's pain is relieved. If the patient is unable to communicate their pain, give opioid medication until the respiratory rate is less than 20/min.
  - If the patient complains of feeling anxious (i.e., is worrying about the future but not complaining of pain) or he cannot express himself but is agitated despite having a respiratory rate less than 20/min, give a benzodiazepine until the anxiety is relieved or the patient is sedated (i.e., is not feeling anxious or is no longer agitated).
- Position the patient as comfortably as possible. Pad pressure points.
- Provide anything that gives the patient comfort (e.g., water, food, cigarette).
- Under no circumstances should paralytics be used without analgesia/sedation

*Link to Analgesia and Sedation Management in Prolonged Field Care, 11 May 2017 CPG [15]

*Link to Pain, Anxiety and Delirium, 26 April 2021 CPG [16]

ANTIBIOTICS, SEPSIS, AND OTHER DRUGS - PCC

Background

Complete Basic TCCC Management Plan for Antibiotics then:

Antibiotics should be given immediately after injury or as soon as possible after the management of MARCH and Pain Management and appropriately documented (medication administered, dose, route and time).

Confirm that initial TCCC dose of moxifloxacin (Avelox®) or Ertapenem (Invanz®) have already been given for any penetrating trauma. If available, administer tetanus toxoid IM as soon as possible.

Antibiotics should be given daily for seven to 10 days, depending on the type of antibiotic given (see below tables for antibiotics). When able/available, transition IV/IO antibiotics to PO as soon as possible to conserve supplies and equipment.

Table 11. TCCC Antibiotics

TCCC Antibiotics	
Moxifloxacin (Avelox®)	Administer 400mg PO daily for 10 days
Ertapenem (Invanz®)	Administer 1g daily IV/IO/IM for 10 days
IV/IO to PO transition	When transitioning from Ertapenem to Moxifloxacin, begin Moxifloxacin immediately after the final dose of Ertapenem for antibiotic overlap

Table 12. Alternative Antibiotics

(used if supplies of TCCC antibiotics are limited, or as directed by medical control)

Alternate Antibiotics			
	Good	**Better**	**Best**
Soft Tissue Injury	Cefalexin PO or Bactrim DS PO Topical: Bacitracin	Cefazolin IM/IV/IO	Moxifloxacin PO or Ertapenem IV/IO Topical: Mupriocin
Suspected MRSA	Topical: Mupirocin	Ertapenem IV/IO	Moxifloxacin PO or Ertapenem IV/IO + Vancomycin
Open Fx (I/II)	Beta-lactam Allergy: Clindamycin IV/IO	Cefazolin IV/IO	Ertapenem IV/IO or Moxifloxacin PO
Open Fx (III) no contamination	Beta-lactam Allergy: Clindamycin IV/IO + Levofloxacin IV/IO	Ceftriaxone IV/IO	Ertapenem IV/IO or Moxifloxacin PO
Open Fx (III) soil or fecal contamination	Beta-lactam Allergy: Levofloxacin IV/IO + Metronidazole IV/IO	Ceftriaxone IV/IO + Metronidazole IV/IO	Ertapenem IV/IO or Moxifloxacin PO
Penetrating Head Injury		Ceftriaxone IV/IO + Metronidazole IV/IO	Ertapenem IV/IO or Moxifloxacin PO
Penetrating Chest Injury			Ertapenem IV/IO or Moxifloxacin PO
Penetrating Abdominal Injury		Ceftriaxone IV/IO + Metronidazole IV/IO	Ertapenem IV/IO or Moxifloxacin PO

Alternate Antibiotics			
Burns (*only* when sepsis is suspected)			Ertapenem IV/IO or Moxifloxacin PO
Eye Injuries	Erythromycin ointment/drops	Ciprofloxacin drops (or if penicillin allergy)	Moxifloxacin PO or Ertapenem IV/IO
Dental Injuries	Pen-VK or Augmentin PO	Clindamycin PO (or IV/IO) or if penicillin allergy	Moxifloxacin PO or Ertapenem IV/IO

Sepsis Management

- Blunt or penetrating injuries may cause sepsis in untreated or undertreated patients
- Early recognition of impending sepsis and immediate treatment are imperative to improve changes of survival
- Maintain a high degree of suspicion for signs of early and/or progressing sepsis while performing continuous triage
- Sepsis is defined as suspected or proven infection plus evidence of end organ dysfunction.
- The National Early Warning Score (NEWS)[17] is an aggregate scoring system indicating early physiologic derangements:

Table 13. Physiologic Parameters and NEWS Score

Physiologic Parameters	**3**	**2**	**1**	**0**	**1**	**2**	**3**
Respiratory Rate	≤8		9-11	12-20		21-34	≥25
Oxygen Saturation	≤91	92-93	94-95	≥96			
Temperature	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1	
Systolic BP	≤90	91-100	101-110	111-219			
Heart Rate	≤40		41-50	51-90	91-110	111-130	≥131
Level of Consciousness				A			V,P,U

- For the purposes of this guideline, a NEWS score of >2 is used to increase the sensitivity for detection of and evaluation for sepsis.
- Early teleconsultations should be used for any signs of sepsis
- Additional parenteral antibiotics may be required to treat sepsis as well as vasopressors.
- All use of pressers should be administered by role-based approved protocols or teleconsultation approval.

NOTE: Surgical telemedicine consultation is highly recommended to guide management of intra-abdominal infections (i.e. appendicitis, cholecystitis, diverticulitis, abdominal abscess).

Sepsis Treatment

Table 14. Sepsis Treatments/Interventions

Intervention	Paradigm
Antimicrobial Therapy	▪ **Minimum** - Moxifloxacin 400 mg PO daily ▪ **Better** - Ertapenem 1 gram IV/IO every 24 hours OR ceftriaxone 2 grams IV/IO every 24 hrs ▪ **Best -** ceftriaxone 2 grams IV/IO every 24 hrs., PLUS vancomycin 1.5 mg/kg IV/IO every 12 hours, PLUS metronidazole 500 mg IV/PO/IO every 8 hours
Antiparasitic Regimens	▪ **Minimum** - Atovaquone/progauanil (Malarone) 4x3 regimen - 4 tablets PO daily for 3 days ▪ **Better/Best** - Artemether/lumefantrine (Coartem) 4 tablets PO initially, then 4 tablets after 8 hours, then 4 tablets PO twice daily for 2 more days (24 tablets total)
Antifungal Regimens	▪ **Minimum/Better/Best** - Fluconazole 400 mg PO/IV daily

Fluid Resuscitation	▪ **Minimum** - In the absence of IV/IO capability, have the patient drink water
	▪ If available, include electrolyte oral rehydration solution, especially for patients who cannot consume food
	▪ **Better** - IV/IO crystalloids:
	  ▪ Initial rapid infusion of 30 ml/kg should be given upon identification of sepsis
	  ▪ LR or NS to maintain SBP > 90mmHg or MAP ≥ 65 mmHg
	  ▪ If plasma is being given that volume can count toward the 30 ml/kg goal
	▪ **Best** - The same fluid resuscitation strategy as above with the addition of a urinary catheter for more precise measuring of UOP

Vasopressors	▪ After fluid resuscitation, if there is no observed positive change in SBP, MAP, UOP and/or mental status, vasopressor medications should be given ▪ *All use of pressers should be administered by role-based approved protocols or teleconsultation approval* ▪ **First-line** - norepinephrine infusion ▪ **Second-line** - epinephrine infusion ▪ Refer to Drip table below for preparation, starting dose, and drip rates
Additional Medications	▪ Consider hydrocortisone or dexamethasone administration for possible adrenal insufficiency if there is a poor response to vasopressor initiation/titration ▪ Administer antipyretics (acetaminophen, if available. Non-steroidal anti-inflammatory drugs [NSAIDs] should be avoided as they may impair renal function)

Table 15. Epinephrine 1:10,000 (Adrenaline) or Norepinephrine (Levophed) Drip

0.9% NaCl IVF Bag Size	Add to bag: EPI (or NOREPI): 1:10,000 (0.1 mg or 100mcg)/mL	Starting Dose (mcg/min)	DRIP SET:10gtts (Drops/mL) DRIP RATE: (Drops/min or gtts/min)	DRIP SET: 15gtts (Drops/mL) DRIP RATE: (Drops/min or gtts/min)
50 mL	1mL (100mcg)	4 mcg/min	20 drops/min	30 drops/min
100 mL	2mL (200mcg)	4 mcg/min	20 drops/min	30 drops/min
250 mL	5mL (500mcg)	4 mcg/min	20 drops/min	30 drops/min
500 mL	10mL (1mg)	4 mcg/min	20 drops/min	30 drops/min
1000 mL (1L)	20mL (2mg)**	4 mcg/min	20 drops/min	30 drops/min

**This is the least recommended approach as it commits a high volume of epinephrine to a large bag. If the patient's vital signs (BP/MAP/HR) stabilize, the bag must be discontinued and the medic risks wasting some of their resources – "you can mix a drug in an IV bag, but you can't take it out."

Ancillary Medications

During PCC, additional medications may be required during the extended treatment of casualties, in addition to pain and antibiotic medications. These medications may have synergistic effects to further reduce pain or fever. Some medications may be utilized to treat side-effects of medications, to include nausea or other GI related issues.

Deep vein thrombosis (DVT) prophylaxis is also recommended for patients that are expected to be in a PCC setting for greater than 48 hours that have achieved hemostasis from wounds or are not at risk for further hemorrhage.

Table 16. Ancillary Medications

	Minimum	Better	Best
Airway	Albuterol MDI Suctioning: Sterile water or 0.9% saline	Albuterol (Neb)	Albuterol (Neb) + Atrovent (Neb)
*Antipyretic	Meloxicam	Acetaminophen PO/PR or Ibuprofen	Acetaminophen IV/IO or Ketoralac IM/IV/IO
Anxiety / Behavioral	See "Pain and Sedation"		
DVT Prophylaxis	Aspirin PO	Heparin SQ	Lovenox SQ
Hydration (PO)	Water	Water + salt + sugar	Water + Gatorade (or other oral rehydration salt)
Hydration (IV/IO)	0.9% Saline or Lactated Ringers	Plasma-Lyte	
Nausea / Vomiting	Alcohol Pad (inhale vapor)	Ondansetron PO or ODT	Ondansetron IV/IO or Metoclopramide IV/IO
GI Medications	Ranitidine PO	Prilosec PO	Protonix IV/IO H1/H2 Blockers IV/IO
GI - Constipation	Bisacodyl PO Glycerin Suppository	Mirilax PO Senna PO	Enema
Sleep	Melatonin PO	Diphenhydramine PO	Zolpidem PO Temazepam PO
Other Medications:	▪ Oral Care (toothbrush/tooth paste and chapstick) ▪ Eye drops (intubated/sedated) ▪ Multi-Vitamins (PO daily) ▪ Animal Bites: Rabies Vaccine and Rabies Immunoglobulin ▪ HIV Prophylaxis (exposure from combat: civilians or enemy forces): PEP Guidance ▪ Regional Medications: Ensure continuing prophylaxis (malaria, etc)		

*Antipyretic: Use caution with NSAIDs with urgent or priority patients. Ensure patient can void normally (no impaired renal function).

*Link to Infection Prevention in Combat-related Injuries, 27 Jan 2021 CPG [18]

*Link to Sepsis Management in Prolonged Field Care, 28 Oct 2020 CPG [19]

WOUND CARE AND NURSING - PCC

Background

Nursing interventions may not appear important to the medical professionals caring for a patient, but such interventions greatly reduce the possibility of complications such as DVT, pneumonia, pressure sores, wound infection, and urinary tract infection; therefore, essential nursing and wound care should be prioritized in the training environment. Critically ill and injured casualties are at high risk for complications that can lead to adverse outcomes such as increased disability and death. Nursing care is a core principle of PCC to reduce the risk of preventable complications and can be provided without costly or burdensome equipment.[20]

- Using a nursing care checklist assists with developing a schedule for performing appropriate assessments and interventions.
- Cross training all team members on these interventions prior to deployment will lessen the demand on the medic, especially when caring for more than one patient.
- Prolonged Casualty Care Flowsheets, Nursing Care Checklists, Nursing Care Plans, Assessment/Intervention Packing List, and Recommended Nursing Skill Checklist for Clinical Rotations are included as a PCC Guidelines Appendix. (Also located in JTS Nursing Intervention in Prolonged Field Care CPG, 22 Jul 2018 [18]).

Pre-deployment, Mission Planning, and Training Considerations

- Hands-on experience is optimal; simulation is a reasonable substitute
- Practice with minimal technology so you are prepared when you lose access to electricity, water
- Regular monitoring, reassessment, and intervention is lifesaving but can be resource-intensive
- Utilize the Recommended Nursing Skill Checklist for Clinical Rotations included in Appendix B to maximize training opportunities.

Table 17. PCC Role-based Guidelines for Nursing Care and Wound Management

PCC Role-based Guidelines for Nursing Care and Wound Management						
TCCC-ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP	**** All Personnel - Complete Basic TCCC Management Plan for Nursing/Wound Management then:*** ▪ Many "nursing" interventions are actually basic soldier skills that need to be performed on those casualties who cannot perform them on themselves. ▪ Therefore, many traditional non-medical tasks are listed at the Tier 1 level since they can essentially be performed by anyone, but the activity can be overseen by medical personnel.		
				Interventions	Frequency	Paradigm
				Lip care	Every hour	▪ **Minimum**: Commercial lip balm ▪ **Better**: Moisturizing lotion ▪ **Best**: Petroleum jelly
				Oral/Nasal Care	24 hours	▪ **Minimum**: Rotate site around mouth/nares, as feasible. ▪ **Better**: Rotate site and suction. ▪ **Best**: Rotate and suction with commercial device.
				Oral/Dental Care	Every 12 hours	▪ **Minimum**: Brush with gauze, water and gloved finger ▪ **Better**: Brush with tooth brush with toothpaste. ▪ **Best**: Use tooth brush with Chlorhexidine rinse.
				Cough/Deep Breathing	Every hour	▪ **Minimum**: Encourage deep breathing/forced cough x 10. ▪ **Better**: Sit up. Encourage deep breathing/forced cough x 10. ▪ **Best**: Sit up, turn, and encourage deep breathing with incentive spirometer/forced cough x 10.
				Repositioning/ Check Padding	Every 2 hours	▪ **Minimum**: Turn to opposite side, pad with clothing or textiles. ▪ **Better**: Turn to opposite side, pad with pillows or blankets. ▪ **Best**: Turn to opposite side, pad with pillows to all bony prominences and between legs.
				Splint Care	Every 2 hours	▪ **Minimum**: Use improvised splints (i.e. wood fence, plank). ▪ **Better**: Use commercial splinting device (e.g., SAM splint). ▪ **Best**: Use ortho-fiberglass splint with fluffing and elastic wrap. ▪ ** Re-check all pulses after splint placemen.t
				Hypothermia Prevention	Continuous	▪ **Minimum**: Wrap patient in dry clothes or blankets. ▪ **Better**: Wrap patient in commercially available hypothermia prevention kit, using air-activated heating element. ▪ **Best**: As above, add use of warmed, forced air and infusion of warmed fluids using commercially available devices.
				Head Injury	Continuous	Elevate head of bed 30 degrees and then: ▪ **Minimum**: Lay patient against ruck sack/backpack ▪ **Better**: Pillows or blankets ▪ **Best**: NATO litter back rest
				Non-medical Interventions	Every hour	▪ **Minimum**: Distract the patient and perform guided imagery. ▪ **Better**: Splint wounds, pad boney prominences, provide ice packs to injured/swollen areas (or, alternate with warm packs). ▪ **Best**: As above, combine both elements.
				Psycho-social Needs	Continuous	▪ **Minimum**: Speak in calm tone, addressing casualty concerns, to reduce fear and anxiety. ▪ **Better**: Support with caring touch, listening to fears/concerns; explain all procedures. ▪ **Best**: Institute rest/sleep cycle system to minimize delirium.

Nutrition	Every 4-6 hours	▪ **Minimum**: If patient is alert, encourage oral food/water intake. ▪ **Better**: As above, use MRE protein powder mixed with water. ▪ **Best**: As above, use commercially available tube feeding products or protein shakes.
Hygiene	Every 24 hours	▪ **Minimum**: Rinse face, armpits, and groin with warm water, soap, and gauze roll. ▪ **Better**: As above, use baby wipes or wash cloth. ▪ **Best**: As above, use chlorhexidine-impregnated cleansing wipes.
Bowel Management	As required	▪ **Minimum**: Cleanse soiled skin as described for bath; reapply new dressings/hypothermia management as appropriate. ▪ **Better**: As above, add a cloth/linen/plastic barrier to protect wounds/hypothermia management kit from future soiling. ▪ **Best**: As above, add barrier cream to skin for protection against breakdown.

▪ Perform all recommended interventions from guidelines for above Tier level.
▪ Additional interventions include:

Intervention	Frequency	Paradigm
IV/IO Site Care		▪ **Minimum**: Flush intravenous catheter every 12 hours; change intravenous infusion tubing every 96 hours. ▪ **Better**: Flush intravenous catheter every 8 hours; change intravenous infusion tubing every 72 hours. ▪ **Best**: Flush intravenous catheter every 4 hours. Change intravenous infusion tubing every 48 hours. ▪ For IO: monitor the site closely for skin compromise (underneath the hub of the IO); if possible, convert to an IV within 24 hours.
Wound Irrigation	Every 24 hours	▪ **Minimum**: Irrigate wound with potable water (cooled before use if boiled) poured across wound ▪ **Better**: As above, use 10cc syringe and 18-gauge angio-catheter. ▪ **Best**: As above, using sterile saline or sterile water or appropriate antimicrobial cleaning solution (i.e. Dankins).
Dressing Change		▪ **Minimum**: Reinforce dressings. ▪ **Better**: Replace when soiled. ▪ **Best**: Change every 24 hours.

▪ Ensure above nursing interventions are completed by non-medical TCCC ASM and CLS personnel.
▪ Conduct inventory of all resources.
▪ Document all pertinent information on PCC Flowsheet (attached).
▪ Additional interventions include:

Intervention	Frequency	Paradigm
Suction mouth/airway, if indicated	As often as required	▪ **Minimum**: Toomey syringe attached to thin tubing ▪ **Better**: Manual suction device ▪ **Best**: Powered suction device
Monitor assisted ventilation	Continuous: every hour	▪ **Minimum**: Use bag-valve-mask ventilation. ▪ **Better**: Mechanical ventilator (without oxygen support), titrate settings based on pulse oximetry. ▪ **Best**: Mechanical ventilator (with oxygen support).
IV Fluid Calculation		▪ **Minimum**: Estimate fluid rate using infusion drip rate calculation. ▪ **Better**: Use “dial-a-flow” technology to control rate of infusion. ▪ **Best**: Use commercial infusion pump.

Deep Vein Thrombosis Prevention ***Pay attention to any wounds to the affected limb***	Every 1-2 hours	▪ **Minimum**: Massage lower extremities ▪ **Better**: As above; add application of compression stockings or elastic bandages to improve venous return. ▪ **Best**: As above; add application of commercial mechanical compression stockings.
Head Injury (Serial Neuro Exams)		▪ **Minimum**: Assess pupillary response, GCS and level of consciousness/orientation, every 8-12 hours; MACE Exam x 1. ▪ **Better**: Neuro exam (as above) every 4 hrs; MACE exam every 24 hrs. ▪ **Best**: Neuro exam (as above) every 1 hr, MACE exam every 24 hrs.
Hyperthermia Prevention/ Treatment		▪ **Minimum**: Expose skin to air. ▪ **Better**: Place cold, wet cloths to groin, neck, armpits (ice packs may cause hypothermia). ▪ **Best**: Use of cooled, forced air and infusion of cooled fluids using commercially available devices.
Administer Antibiotics		▪ **Minimum**: Provide oral or intramuscular injection of antibiotics per CPG. ▪ **Better**: Administer intravenous infusion of broad-spectrum antibiotics, per CPG. ▪ **Best**: Administer wound- or mechanism-specific antibiotics via intravenous infusion, as directed by provider oversight.
Pain Control		▪ **Minimum**: Intermittent dosing of analgesics, given: oral/intramuscular/intravenous/subcutaneous ▪ **Better**: Continuous infusion of analgesics ▪ **Best**: Regional nerve blocks

- Ensure nursing interventions noted above are completed by non-medical TCCC ASM and CLS personnel
- Conduct inventory of all resources
- Document all pertinent information on PCC Flowsheet (attached)
- Additional interventions include:

Intervention	Frequency	Paradigm
Suction Advanced Airway	Every hour	▪ **Minimum**: Manual suction device or improvised suction device, such as a 25cm length portion of IV tubing connected to a 60mL syringe ▪ **Better**: Open suction tube, suction machine ▪ **Best**: Closed inline suction tube, suction machine
Oro/naso-gastric Tube Management		▪ **Minimum**: Cleanse area and rotate position every 12 hours; flush with water every 12 hours (check residuals prior) ▪ **Better**: As above, every 8 hours (check residuals prior) ▪ **Best**: As above, every 4 hours (check residuals prior)
Foley Care	24 hours	▪ **Minimum**: Cleanse around catheter insertion site as part of bath, every 24 hours. ▪ **Better**: Cleanse around catheter insertion site using soap and water, every 12 hours. ▪ **Best**: Cleanse around catheter insertion site using chlorhexidine-impregnated cleansing wipes, every 12 hours.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

*Link to Nursing Intervention in Prolonged Field Care, 22 Jul 2018 CPG [20]
*Link to Acute Traumatic Wound Care in the Prolonged Field Care Setting, 24 Jul 2017 CPG [21]

SPLINTING AND FRACTURE MANAGEMENT - PCC

Table 18. Splinting and Fracture Treatment

Intervention	Paradigm
Litter Padding	▪ **Minimum** - Excess uniforms or other textiles ▪ **Better** - Blankets or military sleep pad ▪ **Best -** Blankets or military sleep pad
Splint Placement	▪ **Minimum** - Improvised splints (wood fence, metal plank, etc.) ▪ **Better** - Commercial splinting device (e.g., SAM splint) ▪ **Best -** Commercial splinting device (e.g., SAM splint) ▪ *Re-check all pulses after splint placement*
Pressure Injury Prevention	▪ Examine skin, including nares and mouth, for changes and ensure splints are fitted properly and pulses are present below splint. ▪ Monitor for allergic reactions to tape, developing erythema, excessive dryness, pressure indenting the skin, cracking, or breakdown. ▪ **Minimum** - As described above, every 2 hours ▪ **Better** - As above, adding padding to elevate bony prominences off of ground/litter/bed ▪ **Best -** As above, adding commercial barrier creams and pressure injury dressings (e.g., Mepilex) to bony prominences

Straps	▪ Patient secured for transport with padding/hypothermia considerations
	▪ All patient care items secured for flight or seaboard transport
	  ▪ Waterproof outer shell (HPMK)
	  ▪ Packaged to resist heavy wind from rotor wash and wind

Litter Padding	▪ **Minimum** - Allow casualty to maintain airway ▪ **Better** - Facial burns may be associated with inhalation injury. Aggressively monitor airway status and place the casualty in a recovery position IAW TCCC Guidelines ▪ **Best -** Given a trauma casualty who is unresponsive or has an airway obstruction, perform a Head-Tilt Chin Lift or Jaw-thrust maneuver to open the airway IAW with TCCC guidelines

Link to JTS Orthopaedic Trauma: Extremity Fractures CPG, 26 Feb 2020[22]

BURN TREATMENT - PCC

Background

- Interrupt the burning process
- Address any life-threatening process based on MARCH assessment as directed by TCCC.
- A burned trauma casualty is a trauma casualty first
- All TCCC skills can be performed through burned tissue

Burn Characteristics

- **Superficial burns (1st degree)** appear red, do not blister, and blanch readily.
- **Partial thickness burns (2nd degree)** are moist and sensate, blister, and blanch.
- **Full thickness burns (3rd degree)** appear leathery, dry, non-blanching, are insensate, and often contain thrombosed vessels

Table 19. PCC Role-Based Guidelines for Burn Management

▪ PCC Role-based Guidelines for Burn Management					
TCCC-ASM	**TCCC-CLS**	**TCCC-CMC**	**TCCC-CPP**	▪ Perform primary and secondary surveys for any trauma patient. Acute injuries found in the primary and secondary survey should be addressed as per standard trauma protocols ▪ Avoid becoming distracted by the appearance of burned tissues.	
				Intervention	Paradigm
				Airway (Roles 1a/1b/1c)	▪ **Minimum** - Allow casualty to maintain airway. ▪ **Better** - Facial burns may be associated with inhalation injury. Aggressively monitor airway status and place the casualty in a recovery position IAW TCCC Guidelines. ▪ **Best** - Given a trauma casualty who is unresponsive or has an airway obstruction, perform a Head-Tilt Chin Lift or Jaw-thrust maneuver to open the airway in accordance with TCCC guidelines.
				Fluid Resuscitation (Roles 1a/1b/1c)	▪ Estimate body total surface area (TBSA) burned using the Rule of Nines initially (DD Form 1380). ▪ Note - Superficial (First-degree burns) are NOT used in the TBSA calculation. ▪ If burns >20% TBSA, fluid resuscitation should be initiated as soon as IV/IO access is established. ▪ **Minimum** - Oral intake of water ▪ **Better** - Oral intake of electrolyte solution ▪ **Best** - Oral intake of electrolyte solution
				Hypothermia (Roles 1a/1b/1c)	▪ Hypothermia prevention is extremely important for burn patients. ▪ For Burns >20%, place the casualty in the Heat-Reflective Shell or Blizzard Survival blanket for the Hypothermia Prevention Kit to both cover the burned areas and prevent hypothermia.

Pain Control	Analgesia in accordance with the PCC Guidelines may be administered to treat burn pain.
Wounds (Roles 1a/1b)	▪ **Minimum** - Cover with clean sheet or dry gauze. Leave blisters intact. Avoid wet dressings. ▪ **Better** - Clean wounds by washing with any clean water (preferably with antibacterial soap if available), dress wounds with any available dressings; optimize wound and patient hygiene to the extent possible given the environment. ▪ **Best** - Clean wounds by scrubbing gently with gauze and clean water, followed by gauze dressing.
Wounds (Role 1c)	▪ **Best** - Clean wounds by scrubbing gently with gauze and **chlorhexidine gluconate solution (if available)** in clean water, followed by gauze dressing. Repeat daily. ▪ Monitor vital signs.
▪ Ensure all interventions noted above are completed by TCCC ASM and CLS personnel. ▪ Conduct inventory of all resources. ▪ Document all pertinent information on PCC Flowsheet (attached). ▪ Additional interventions include:	
Intervention	Paradigm
Airway (Roles 1a/1b/1c)	▪ **Minimum** - Allow casualty to maintain airway. ▪ **Better** - Facial burns may be associated with inhalation injury. Aggressively monitor airway status and consider early surgical airway for respiratory distress or oxygen saturation and/or EtCO2 (purple-gold colorimetric device). ▪ **Best** - Given a trauma casualty who is unresponsive or has an airway obstruction, consider early surgical airway.
Fluid Resuscitation (Roles 1a/1b/1c)	▪ **Minimum** - Oral intake of water. Rectal infusion of up to 500mL/h can be supplemented with oral hydration. ▪ **Better** - Oral intake of electrolyte solution. ▪ **Best** - Start intravenous (IV) or intraosseous (IO) administration immediately. NOTE - an IV/IO can be placed through burned skin if necessary. ▪ Use isotonic crystalloids (i.e. Lactated Ringers). ▪ DO NOT circumferentially tape lines around extremities; this may further impede circulation and cause limb ischemia as extremities swell during resuscitation. ▪ NO bolus (unless hypotensive, in which case, bolus only until palpable pulses are restored). ▪ Initial IV rate 500mL/h; start while completing initial assessment ▪ Give fluids per TCCC burn treatment guidelines. ▪ If resuscitation is delayed, DO NOT try to “catch up” by giving extra fluids. ▪ Blood products may be used in major burn resuscitation due to coagulopathy, anemia, and bleeding from escharotomy sites or other traumatic injuries. ▪ Maintain a UOP of 30-50mL/hr. in adults; decrease or increase isotonic fluid rate by 20-25% per hour. ▪ If UOP > 50 mL/hr., then decrease the fluid rate by 20-25% for the next hour and reassess. ▪ Minimize fluid administration while maintaining organ perfusion; hour-to-hour fluid management is critical.

	▪ **8-12 hours post-burn**, if the hourly IV fluid rate exceeds 1500mL/hr. or if the projected 24- hour total fluid volume approaches 250 mL/kg consult burn team or medical director. ▪ **24–48 hours post burn**, plasma is lost into the burned and unburned tissues, causing hypovolemic shock (when burn size is >20%). The goal of burn-shock resuscitation is to replace these ongoing losses while avoiding over-resuscitation. ▪ **48-72 hours post-burn**, completion of the resuscitation is marked by stabilizing hemodynamic parameters and reduction of IV fluid rate to a maintenance level.
Hypothermia (Roles 1a/1b/1c)	▪ Hypothermia prevention is extremely important for burn patients. ▪ For Burns >20%, place the casualty in the Heat-Reflective Shell or Blizzard Survival blanket for the Hypothermia Prevention Kit to both cover the burned areas and prevent hypothermia. ▪ Use Blood/Fluid Warmer as needed and if available.
Pain Control (Roles 1a/1b/1c)	Analgesia in accordance with the PCC Guidelines may be administered to treat burn pain.
Medications (Roles 1a/1b)	▪ Prophylactic antibiotics (oral or IV) are not indicated for burn injury in the absence of infection. ▪ Penetrating wounds or open fractures should be treated with antibiotics according to current TCCC guidelines.
Medications (Role 1c)	▪ After several days, if the patient develops cellulitis (spreading erythema around edges of burn), treat for gram-positive organisms, (e.g., cefazolin or clindamycin). ▪ If patient develops invasive burn wound infection (signs: sepsis/septic shock, changes in color of wound, possible foul smell of wound), treat with broad-spectrum antibiotics.
Wounds (Role 1a)	▪ **Minimum** - Cover with clean sheet or dry gauze. Leave blisters intact. Avoid wet dressings. ▪ **Better** - Clean wounds by washing with any clean water (preferably with antibacterial soap if available), dress wounds with any available dressings; optimize wound and patient hygiene to the extent possible given the environment. ▪ **Best** - Clean wounds by scrubbing gently with gauze and clean water, followed by gauze dressing. ▪ DO NOT debride blisters until the patient has reached a facility with surgical capability. ▪ Every patient with facial burns should have a thorough eye exam. Conduct an eye exam early, before edema begins. ▪ If a corneal injury is identified, use a rigid shield to cover the eyes and apply ophthalmic erythromycin or neomycin ointment every 2 hours.
Wounds (Roles 1b/1c)	▪ **Better** - Clean wounds and **debride loose skin** by washing with any clean water (preferably with antibacterial soap if available), dress wounds with any available dressings; optimize wound and patient hygiene to the extent possible given the environment. ▪ **Best** - Clean wounds by scrubbing gently with gauze and **chlorhexidine gluconate solution (if available**) in clean water, apply topical antimicrobial cream followed by gauze dressing.

Monitoring	▪ Monitor vital signs and urine output (UOP) closely. ▪ **Minimum** - Use other measures If unable to measure UOP, adjust IV rate to maintain HR less than 140, palpable peripheral pulses, good capillary refill, intact mental status. ▪ **Better** - Capture all spontaneously voided urine in premade or improvised (i.e. Nalgene® water bottle) graduated cylinder; >180mL every 6 hours is adequate for adults. ▪ **Best** - Measure UOP with Foley catheter (burns to the penis are NOT a contraindication to catheter placement).

- Ensure all above interventions are completed by TCCC ASM, CLS and CMC personnel.
- Conduct inventory of all resources.
- Document all pertinent information on PCC Flowsheet (attached.)
- Additional interventions include:

Intervention	Paradigm
Airway (Roles 1a/1b/1c)	▪ **Minimum** - Allow casualty to maintain airway. Edema after burn injury causes most supraglottic airway devices such as LMAs to be inadequate. ▪ **Better** - Facial burns may be associated with inhalation injury. Aggressively monitor airway status and consider early surgical airway for respiratory distress or oxygen saturation and/or EtCO2 (purple-gold colorimetric device). ▪ **Best** - Indications for endotracheal intubation include: a comatose patient, symptomatic inhalation injury, deep facial burns, and burns over 40% TBSA. ▪ Utilize an EMMA (or other Capnography) EtCO2 device if possible. ▪ Use a large-bore endotracheal tube if inhalation injury is suspected (Size 8 ETT or larger is preferred for adults). ▪ Secure ETT with cotton umbilical ties (standard adhesive ETT holders do not work around burned skin). ▪ Frequently reassess position of the ETT during the acute resuscitation period as edema waves and wanes.

Legend:	TCCC - ASM	TCCC-CLS	TCCC-CMC	TCCC-CPP

*Link to Burn Wound Management in Prolonged Field Care, 13 Jan 2017 CPG [23]

Special Considerations in Burn Injuries

Chemical Burns

NOTE: Refer to the JTS Inhalation Injury and Toxic Industrial Chemical Exposure CPG for additional information.

- Expose body surfaces, brush off dry chemicals, and copiously irrigate with clean water. Large volume (>20L) serial irrigations may be needed to thoroughly cleanse the skin of residual agents. Do not attempt to neutralize any chemicals on the skin.
- Use personal protective equipment to minimize exposure of medical personnel to chemical agents.
- White phosphorous fragments ignite when exposed to air. Clothing may contain white phosphorous residue and should be removed. Fragments embedded in the skin and soft tissue should be irrigated out if possible or kept covered with soaking wet saline dressings or hydrogels.
- Seek early consultation from the USAISR Burn Center (DSN 312-429-2876 (BURN); Commercial (210) 916-2876 or (210) 222-2876; email usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil).

Electrical Burns

- TCCC ASM and CLS personnel should remove the patient from the electricity source while avoiding injury themselves.
- For cardiac arrest due to arrhythmia after electrical injury, follow advanced cardiac life support (ACLS) protocol and provide hemodynamic monitoring if spontaneous circulation returns.
- Small skin contact points (cutaneous burns) can hide extensive soft tissue damage.
- Observe the patient closely for clinical signs of compartment syndrome.
- Tissue that is obviously necrotic must be surgically debrided.

NOTE: Escharotomy, which relieves the tourniquet effect of circumferential burns, will not necessarily relieve elevated muscle compartment pressure due to myonecrosis associated with electrical injury; therefore, fasciotomy is usually required.

- Compartment syndrome and muscle injury may lead to rhabdomyolysis, causing pigmenturia and renal injury.
- Pigmenturia typically presents as red-brown urine. In patients with pigmenturia, fluid resuscitation requirements are much higher than those predicted for a similar-sized thermal burn.
- Isotonic fluid infusion should be adjusted to maintain UOP 75-100 mL/hr. in adult patients with pigmenturia.
- If the pigmenturia does not clear after several hours of resuscitation consider IV infusion of mannitol, 12.5 g per liter of lactated Ringer's solution, and/or sodium bicarbonate (150 mEq/L in D5W). These infusions may be given empirically; it is not necessary to monitor urinary pH. In patients receiving mannitol (an osmotic diuretic), close monitoring of intravascular status via CVP and other parameters is required.

- Seek early consultation from the USAISR Burn Center (DSN 312-429-2876 (BURN); Commercial (210) 916-2876 or (210) 222-2876; email usarmy.jbsa.medcom-aisr.list.armyburncenter@health.mil).

Pediatric Burn Injuries

- Children with acute burns over 15% of the body surface usually require a calculated resuscitation.
- Place a bladder catheter if available (size 6 Fr for infants and 8 Fr for most small children).
- The Modified Brooke formula (3 mL/kg/%TBSA LR or other isotonic fluid divided over 24 hours, with one-half given during the first 8 hours) is a reasonable starting point. This only provides a starting point for resuscitation, which must be adjusted based on UOP and other indicators of organ perfusion. Goal UOP for children is 0.5-1mL/kg/hr.
- Very young children do not have adequate glycogen stores to sustain themselves during resuscitation. Administer a maintenance rate of D5LR to children weighing < 20 kg. Utilize the 4-2-1 rule: 4ml/kg for the first 10kg + 2ml/kg 2nd 10kg + 1ml/kg over 20kg.
- In children with burns > 30% TBSA, early administration may reduce overall resuscitation volume.
- Monitor resuscitation in children, like adults, based on physical examination, input and output measurements, and analysis of laboratory data.
- The well-resuscitated child should have alert sensorium, palpable pulses, and warm distal extremities; urine should be glucose negative.
- Cellulitis is the most common infectious complication and usually presents within 5 days of injury. Prophylactic antibiotics do not diminish this risk and should not be used unless other injuries require antimicrobial coverage (penetrating injury or open fracture).
- Most antistreptococcal antibiotics such as penicillin are successful in eradicating infection. Initial parenteral administration is advised for most children presenting with fever or systemic toxicity.
- Nutrition is critical for pediatric burn patients. Nasogastric feeding may be started immediately at a low rate in hemodynamically stable patients and tolerance monitored. Start with a standard pediatric enteral formula (i.e. Pediasure) targeting 30-35 kcal/kg/day and 2g/kg/day of protein.
- Children may rapidly develop tolerance to analgesics and sedatives; dose escalation is commonly required. Ketamine and propofol are useful procedural adjuncts.
- When burned at a young age, many children will develop disabling contractures. These are often very amenable to correction which may be performed in theater with adequate staff and resources.
- Seek early consultation from the USAISR Burn Center (DSN 312-429-2876 (BURN); Commercial (210) 916-2876 or (210) 222-2876; email burntrauma.consult.army@mail.mil).
- Opportunities for pediatric surgical care provided by Non-Governmental Organizations (NGOs) may be the best option but require the coordinated efforts of the military, host nation, and NGOs.

Rule of Nines

On the DD Form 1380 the percentage of coverage on the casualty's body will need to be documented. The Rule of Nines will help with the estimation. The below figure shows the approximation for each area of the body:

- Eleven areas each have 9% body surface area (head, upper extremities, front and backs of lower extremities, and front and back of the torso having two 9% areas each).
- General guidelines are that the size of the palm of the hand represents approximately 1% of the burned area.
- When estimating, it is easiest to round up to the nearest 10.
- If half of the front or rear area is burned, the area would be half of the area value.
- For example, if half of the front upper/lower extremity is burned, it would be half of 9%, or 4.5%. If half of the front torso is burned, say either the upper or lower part of the front torso, then it would be half of 18%, or 9%.
- Remember, the higher the percentage burned, the higher the chance for hypothermia.
- For children, the percentage of BSA is calculated differently due to the distinctive proportion of major areas.

Figure 2. Adult Rule of Nines

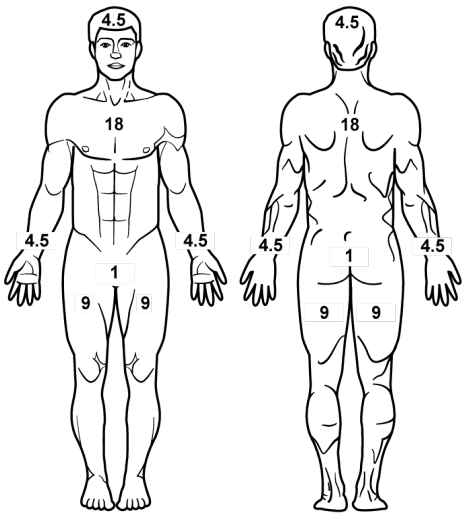
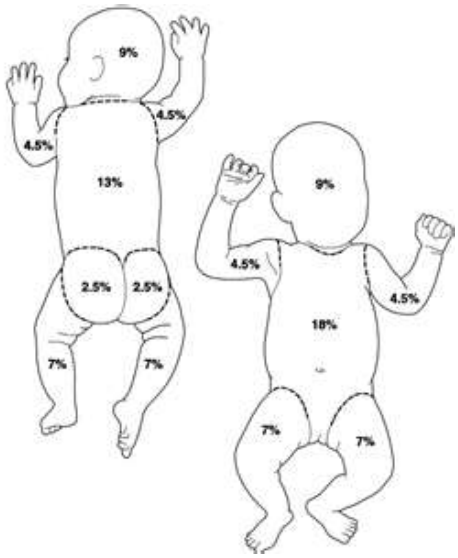


Figure 3. Pediatric Rule of Nines



Link to Burn Wound Management in Prolonged Field Care, 13 January 2017 CPG [23]

LOGISTICS - PCC

Background

Reducing the time to required medical or surgical interventions prevents death in potentially survivable illness, injuries and wounds. When evacuation times are extended, en route care (ERC) capability must be adequately expanded to mitigate the delay. In January 2010, the J*oint Force Health Protection Joint Patient Movement Report stated* "the current success of the medical community is colored by the valiant ability to overcome deficiencies through 'just-in-time workarounds;' many systemic shortfalls are resolved and become transparent to patient outcomes. However, future operations may not tolerate current deficiencies." [24]

- Patient packaging is highly dependent upon the transportation or evacuation platform that is available
- If possible, rehearse patient packaging internally and with the external resources.
- Train with all possible assets, familiarizing them with standard operating procedures
- Ensure the patient is stable before initiating a critical patient transfer

Table 20. Logistics Interventions

Intervention	Paradigm
Prepare Documentation	▪ **Minimum** - TCCC Card - DA1380 ▪ **Better** - Prolonged Field Care Casualty Work Sheet ▪ **Best** - PCC Card with TCCC Card and any additional information, reference DA Form 4700 (SMOG 2021) for transport documentation standard.
Prepare Report	▪ Report should give highlights, expected course, and possible complications during transport. ▪ *The hand-off is the most dangerous time for the patient;* it is as important as treatments or medications. ▪ If it is rushed, things can easily be missed. ▪ Make sure you highlight non-obvious interventions and aspects of care (drugs given, repeat doses, etc.). ▪ **Minimum** - Verbal report describing the patient from head to toe with interventions or a SOAP note. ▪ **Better -** MIST (Mechanism, Interventions, Symptoms, Treatments) ▪ **Best** - MIST with appropriate SBAR (Situation, Background, Assessment, Recommendations) and pertinent labs and other diagnostic information
Prepare Medications	▪ **Minimum** - Prepare medication list with doses and time of next dose. ▪ **Better** - Above with additionally preparing next dose of medication for transport crew appropriately labeled. ▪ **Best** - Above with fresh IV fluids if indicated and fresh bags of drip medications with appropriate labeling and 72 hours of antibiotic for extended transports..
Hypothermia Management	▪ **Minimum** - Blankets ▪ **Better** - Sleep system and blankets. ▪ **Best** - HPMK with Ready Heat or Absorbent Patient Litter System (APLS). ▪ If possible, identify with tape the location of interventions or access points *on top of* hypothermia management to allow transport teams quick identification of location.

Intervention	Paradigm
Flight Stressor/ Altitude Management	▪ **Minimum** - Ear Protection and Eye Protection, if nothing available sunglasses and gauze may be used, if patient is sedated and intubated eyes can be taped shut. ▪ **Better** - Ear Pro and Eye Pro and blankets in all bony areas, Ear Protection and Eye Protection – foam ear plugs or actual hearing protection inserts, goggles. ▪ **Best** - Above with gastric tube (NG/OG) or chest tube for decompression, if indicated. Depending on altitude/platform, consider bleeding air of out bags of fluid.

Secure Interventions and Equipment	▪ **Minimum** - Tape:
	  ▪ Securely tape all interventions to include IVs, IOs, airway interventions, gastric tubes and TQs).
	  ▪ Oxygen tanks should be placed between the patients' legs and the monitor should be secured on the oxygen cylinder to prevent injury to the patient.
	  ▪ Pumps should be secured to the litter.
	▪ **Better** - Additional litter straps to secure equipment and extend the litter with back support as indicated for vented patients to prevent VAP
	▪ **Best** - Above. Use the Special Medical Emergency Evacuation Device (SMEED) to keep the monitor and other transport equipment off patient.

Prepare Dressings	▪ AE and Other MEDEVAC assets *do not routinely change dressings during transport*; therefore, ensure all dressings are changed, labeled, and secured before patient pick up. ▪ **Minimum** - Secure and reinforce dressings with tape, date, and time all dressings. ▪ **Better** - Change dressings within 24 hours of departure, secure as above. ▪ **Best** - Change and reinforce dressings within 4 hours of departure. Ensure additional Class VIII is available for any unforeseen issues in flight. ▪ **CAUTION -** Circumferential/constricting dressings MUST be limited/monitored due to swelling during prolonged aerial transport.
Secure the Patient	▪ **Minimum** - Litter with minimum of 2 litter straps. ▪ **Better** - Litter with padding (example: AE pad or Sleep Mat) with minimum of 3 litter straps. ▪ **Best -** Litter with padding and flight approved litter headrest with minimum of 3 litter straps. ▪ Additional litter straps can be used to secure patient or equipment.
Moving a Critical Care Patient	▪ **Minimum** - Two-person litter carry to CASEVAC/MEDEVAC platform. ▪ **Better** - Three-person litter carry to CASEVAC/MEDEVAC platform. ▪ **Best -** Four-person litter carry to CASEVAC/MEDEVAC platform.

*Link to Interfacility Transport of Patients between Theater Medical Treatment Facilities, 24 Apr 2018 CPG

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APPENDIX A: TCCC GUIDELINES

TCCC Guidelines

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://deployedmedicine.com/market/31/content/40

APPENDIX B: AIRWAY RESOURCES

Nursing Care Checklist

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://prolongedfieldcare.org/wp-content/uploads/2018/05/PFC-Nursing-Care-Plan_.pdf

APPENDIX C: MASCAL RESOURCES

Triage Guiding Principles

- Priorities change based on time from injury
- Activities in first hour are **CRITICAL**
- Don't waste time with formal triage tools
  Just extricate/stop threat, stop external bleeding, clear airway
- Transfusion and ventilator support within the first hour identify a resource-intensive patient
- Damage control surgery has little impact after the first hour

Figure 4. TRIAGE cheat cards START

<table>
<tr><td colspan="4">START TRIAGE: Assess, Treat (use bystanders)
When you have a color: STOP – TAG – MOVE ON</td></tr>
<tr><td rowspan="8">MINOR</td><td colspan="3">Move walking wounded</td></tr>
<tr><td rowspan="7">DECEASED</td><td colspan="2">No RESPIRATIONS after head tilt</td></tr>
<tr><td rowspan="6">IMMEDIATE</td><td>Breathing but UNCONSCIOUS</td></tr>
<tr><td>Respirations over 30</td></tr>
<tr><td>Perfusion capillary refill > 2 or NO RADIAL PULSE
Control bleeding</td></tr>
<tr><td>Mental Status: unable to follow simple commands</td></tr>
<tr><td rowspan="2">DELAYED</td><td>Otherwise</td></tr>
<tr><td>Remember:
Respirations – 30
Perfusion – 2
Mental Status – Can Do</td></tr>
</table>

Table 21. Triage Assessment

Each Patient Triage Assessment Should Be Complete in Less Than 60 Seconds	
Category	**Examples**
Category I: Immediate (red chemlite)	▪ (Any MARCH issue) ▪ Airway obstruction ▪ Flail/open chest wound ▪ Tension- Pneumothorax/hemothorax ▪ Massive hemorrhage ▪ 20-70% Burns ▪ Unstable Vital Signs ▪ Severe TBI (unconscious alive Pt)
Category II: Delayed (green chemlite)	▪ Open fractures w/PMS intact ▪ Soft tissue injuries ▪ Moderate TBI (stable vital signs) ▪ Open abdominal wounds
***Category III: Minimal (no chemlite) remain armed continue to engage**	▪ Minor abrasions, burns, sprains lacerations ▪ Moderate/Mild anxiety ▪ Fractures/dislocations w/PMS ▪ Mild TBI
****Category IV: Expectant or Hero (blue chemlite)**	▪ Massive head or spinal injury ▪ Third degree burns > 70% BSA ▪ Injuries incompatible with life

** In combat, it is assumed that minimals will continue to stay armed/engaged if no mental status altering pharmaceuticals are given for pain.*

**Expectant category is ONLY used in combat operations and/or when the requirements to adequately treat these patients exceed the available resources. In peacetime, it is generally assumed that all patients have a chance of survival.

Source: Special Operations Force Medic Handbooks (PJ, Ranger)

Triage Class 1 (MASCAL)

Adequate medics to treat critical patients and handle the rest

- Many casualties
- Threat controlled
- Resources not severely limited
- Medical personnel can arrive
- Evacuation possible

Table 22. Triage Class 1 Actions and Goals

<1 Hour After Injury	1 – 4 Hours After Injury	>4 Hours After Injury
Goals	**Goals**	**Goals**
▪ Eliminate Threat ▪ Establish CCP ▪ Blood transfusion within 30 minutes ▪ Evacuate to DCR/DCS within 1 hour	▪ DCR/DCS as soon as possible ▪ Use advanced resuscitation to "extend the Golden Hour"	Evacuate
Actions	**Actions**	**Actions**
▪ Stop external bleeding ▪ Clear airway ▪ Ensure ventilation ▪ Formal triage ▪ Transfuse	▪ MARCH PAWS ▪ Transfuse	Use prolonged care to optimize outcomes

Triage Class 2 (MASCAL)

Unable to manage the number of critical patients

- Numerous casualties or MASCAL (i.e. < 100 Casualties)
- Threat has been controlled or partially controlled
- Resources are very limited
- Medical personnel can arrive (may be delayed > 1 hour)
- Evacuation is possible (may be delayed > 1 hour)

Table 23. Triage Class 2 Actions and Goals

<1 Hour After Injury	1 – 4 Hours After Injury	>4 Hours After Injury
Goals	**Goals**	**Goals**
▪ Eliminate threat ▪ Get medical personnel on scene ▪ Begin evacuation of urgent but survivable patients	▪ Evacuate urgent and priority patients ▪ DCR/DCS as soon as possible	Evacuate remainder of patients
Actions	**Actions**	**Actions**
▪ Stop external bleed ▪ Clear airway ▪ Reserve intubation/transfusion ▪ CCP if able, otherwise get a count	▪ Formal triage ▪ MARCH PAWS if able ▪ Transfuse ▪ Establish CCP ▪ Utilize minimals/returns to duty	▪ Re-triage ▪ Complete MARCH PAWS ▪ Use prolonged care to optimize outcomes ▪ Wound/fracture management

Triage Class 3 (Ultra-MASCAL)

Absolutely overwhelming number of casualties

- Ultra-MASCAL (i.e. >100, possibly thousands of casualties)
- Threat is ongoing
- Resources are severely limited
- Medical personnel unable to arrive in < 1 Hour
- Evacuation not possible in < 1 Hour

Table 24. Triage Class 3 Actions and Goals

<1 Hour After Injury	1 – 4 hours After Injury	>4 Hours After Injury
Goals	**Goals**	**Goals**
▪ Respond to threat ▪ Self-aide, buddy care ▪ Separate ambulatory/ non-ambulatory	▪ Eliminate threat ▪ Get medical personnel on scene ▪ Begin evacuation	▪ Evacuate ▪ Distribute patients
Action	**Action**	**Action**
▪ Stop external bleed ▪ Clear airway ▪ Reverse intubation/ transfusion ▪ Get a count	▪ Stop external bleed ▪ Reserve intubation/transfusion ▪ Begin to establish CCPs ▪ Utilize minimals/return to Duty	▪ Formal triage ▪ Use prolonged care to optimize outcomes ▪ Wound/fracture management ▪ Utilize minimals/return to duty

MASCAL/Austere Team Resuscitation Record

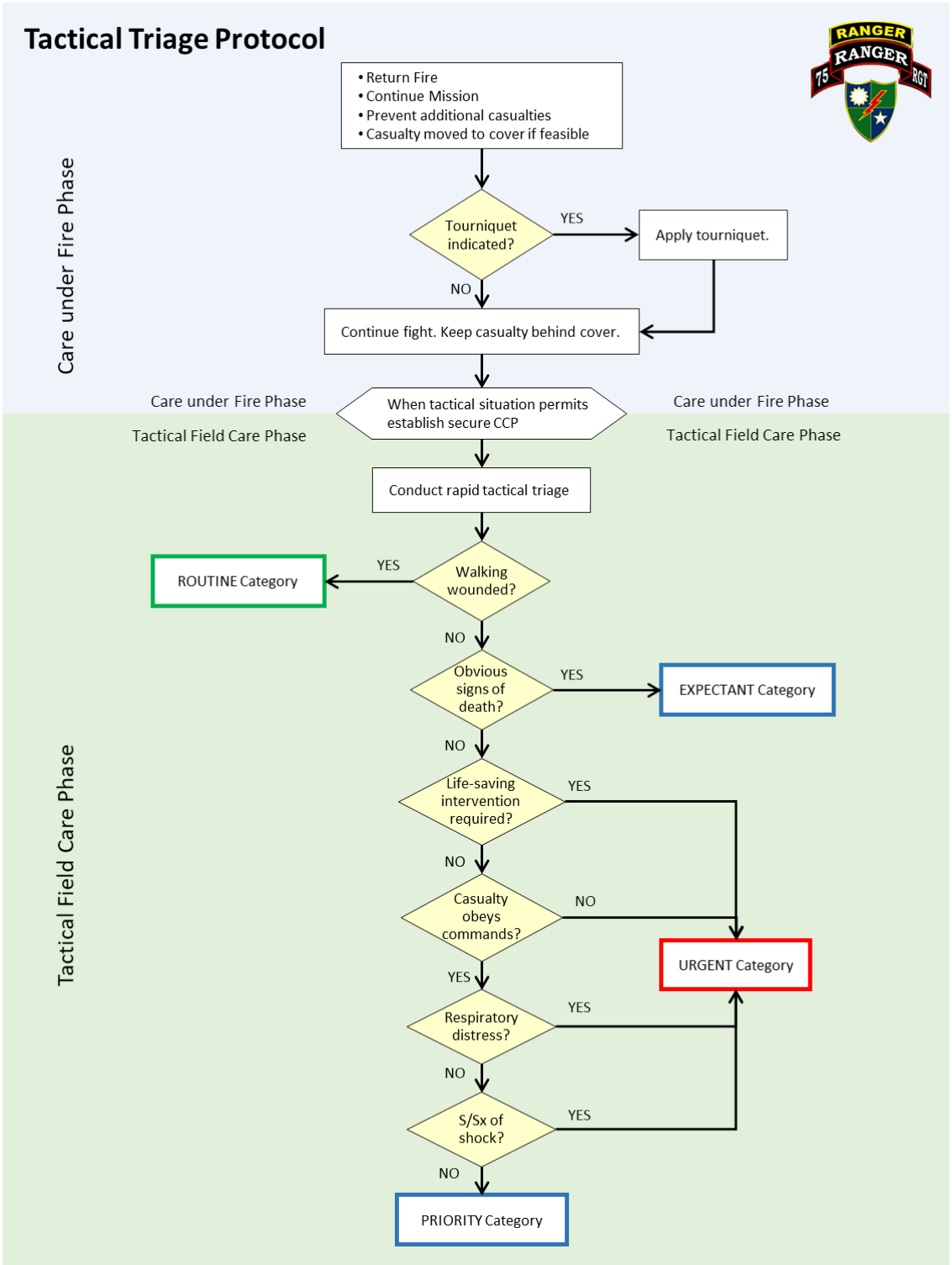
Open the attachment on the side menu or open the below link to print or fill out electronically.

https://jts.amedd.army.mil/assets/docs/forms/MASCAL_Austere_Trauma_20_Jan_2020.pdf

Instructions: https://jts.amedd.army.mil/assets/docs/forms/MASCAL_Form_Instructions.pdf

Tactical Triage Protocol (algorithm)

Figure 5. Tactical Triage Protocol



APPENDIX D: DOCUMENTATION RESOURCES

The following resources and associated links are included in this CPG as attachments.

- DD 1380 TCCC Card and accompanying POI TCCC After Action Report
- DD 3019 Resuscitation Record
- DA 4700 TACEVAC form
- Nursing care grid (See Appendix B.)
- Teleconsultation Script

DD 1380 TCCC Card

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://jts.health.mil/index.cfm/documents/forms_after_action

DD 1380 - POI TCCC After Action Report

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://jts.health.mil/index.cfm/documents/forms_after_action

DD 3019 Resuscitation Record

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://www.esd.whs.mil/Portals/54/Documents/DD/forms/dd/dd3019.pdf

DA 4700 TACEVAC Form

Open the attachment on the side menu or open the below link to print or fill out electronically.

Instructionshttps://jts.health.mil/index.cfm/documents/forms_after_action

Prolonged Field Care Casualty Card v22.1, 01 Dec 2020

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://jts.health.mil/assets/docs/forms/Prolonged_Field_Care_Casualty_Card-Worksheet.pdf

Virtual Critical Care Consultation Guide

Guide is to be used with the Prolonged Field Care Card.

1. Before calling, E-mail image of the casualty (wounds, environment, etc.), "capabilities" (back of page), & vital signs trends to _____ **2. If call not answered: a) call next number on PACE or call back in 5 – 10 min.** **3. If unable to provide information due to operational security, state so.**

P: **A:** **C:** **E:**

This is _____ I am a (job/ position) _____ **My best** contact info is: _____ **YOUR best** contact info is (Consultant's number): _____Alternate e-mail: _____

****** PAUSE POINT to CONFIRM CONTACT INFO******

I have a _____ year–old _____(sex) _____ (active duty/foreign national/OGA,etc.), who has the following:
Mechanism of Injury or known diagnosis(es) that occurred in (location)
The injury/start of care occurred *hours ago*. Anticipated *evacuation time* is (range)
Injuries/Problems/**S**ymptoms:
Treatments:
He/she is currently (circle) stable/ unstable, getting better/ getting worse/ getting worse rapidly
Known Medication Allergies/Past medical/Surgical history is:
I need help with (*be specific if possible, i.e. "I need help reading this ECG," or "I need help stabilizing this patient," etc.)*
Other Consultants have recommended:

****** PAUSE POINT for Remote Consultant to ask clarification questions ******

VITALS (*current* & *trend* as of): HR		BP	RR	SpO2	ETCO2
Temp…….					
UOP(ml/hr)	over		(# hours) Mental Status (GCS/ AVPU)		
EXAM: Neuro			Ext/ MSK		
Heart			Pulses		
Lungs			Skin/ Wounds		
Abd					
LABS: ABG:		Lactate:	Other:		

*** PAUSE POINT for Remote Consultant to ask clarification questions **

Virtual Critical Care Consultation Guide – page 2

Plans/Recommendations		
PRIORITY	**SYSTEM/PROBLEM**	**RECOMMENDATION**
	Neuro or problem #1	
	CV or problem #2	
	Pulm or problem #3	
	GI or problem #4	
	Renal or problem #5	
	Endocrine or problem #6	
	MSK/ Wound or problem #7	
	Tubes, lines, drains or problem #8	
	Prophylaxis/prevention or prob#9	
	Other	

TO-DO/ FOLLOW-UP/TO-STOP	**NOTES**
1.	
2.	
3.	
4.	
5.	
6.	

****** PAUSE POINT, for Medic/Local Caregiver to ask clarification questions/READBACK******

Available "kit" (supplies, equipment, medications) !! IF POSSIBLE PHOTOGRAPH AND SEND VIA EMAIL BEFORE CALLING !!

IV access: IV Central line IO (location) Other:_____

Monitor: Propaq Tempus Foley Graduated urinal PulseOx only Exam Only
Other:_____

Commo: Tempus i2i ID: _____THIAB:_____SAT#_____Local Cell#_____
Web VTC Address_____
Other (e.g. "FaceTime, VSee, Skype, etc.):_____

IV Fluids: Plasma-Lyte LR Normal Saline 3% saline
Other:_____

Colloids: Hetastarch Albumin
Other:_____

Blood products: Whole blood PRBC Plasma FDP Platelets
Other:_____

Medications: Antibiotics: name/route/dose_____
Morphine IV/ PO Other opioid (name/ IV/ PO):
_____
Fentanyl IV/ PO (pop) Ketamine
Midazolam Diazepam (IV/ PO)
TXA Other(s):
_____

Airway supplies: ETT Cric kit LMA Ventilator BVM O2 Suction

Misc:

APPENDIX E: TBI RESOURCES

Neurological Examination

MENTAL STATUS

Level of Consciousness: Note whether the patient is:

- Alert/responsive
- Not alert but arouses to verbal stimulation
- Not alert but responds to painful stimulation
- Unresponsive

Orientation: Assess the patient's ability to provide:

- Name
- Current location
- Current date
- Current situation (e.g., ask the patient what happened to him/her)

Language: Note the fluency and appropriateness of the patient's response to questions. Note patient's ability to follow commands when assessing other functions (e.g., smiling, grip strength, wiggling toes). Ask the patient to name a simple object (e.g., thumb, glove, watch).

Speech: Observe for evidence of slurred speech.

CRANIAL NERVES

All patients:

- Assess the pupillary response to light.
- Assess position of the eyes and note any movements (e.g., midline, gaze deviated left or right, nystagmus, eyes move together versus uncoupled movements).
- Noncomatose patient:
- Test sensation to light touch on both sides of the face.
- Ask patient to smile and raise eyebrows, and observe for symmetry.
- Ask the patient to say "Ahhh" and directly observe for symmetric palatal elevation.
- Comatose patient:
- Check corneal reflexes; stimulation should trigger eyelid closure.
- Observe for facial grimacing with painful stimuli.
- Note symmetry and strength.
- Directly stimulate the back of the throat and look for a gag, tearing, and/or cough.

MOTOR

Tone: Note whether resting tone is increased (i.e. spastic or rigid), normal, or decreased (flaccid).

Strength: Observe for spontaneous movement of extremities and note any asymmetry of movement (i.e. patient moves left side more than right side). Lift arms and legs, and note whether the limbs fall immediately, drift, or can be maintained against gravity. Push and pull against the upper and lower extremities and note any resistance given. Note any differences in resistance provided between the left and right sides.

(NOTE: it is often difficult to perform formal strength testing in TBI patients. Unless the patient is awake and cooperative, reliable strength testing is difficult.)

Involuntary movements: Note any involuntary movements (e.g., twitching, tremor, myoclonus) involving the face, arms, legs, or trunk.

SENSORY

If patient is not responsive to voice, test central pain and peripheral pain.

Central pain: Apply a sternal rub or supraorbital pressure, and note the response (e.g., extensor posturing, flexor posturing, localization).

Peripheral pain: Apply nail bed pressure or take muscle between the fingers, compress, and rotate the wrist (do not pinch the skin). Muscle in the axillary region and inner thigh is recommended. Apply similar stimulus to all four limbs and note the response (e.g., extensor posturing, flexor posturing, withdrawal, localization).

NOTE: In an awake and cooperative patient, testing light touch is recommended. It is unnecessary to apply painful stimuli to an awake and cooperative patient.

GAIT

If the patient is able to walk, observe his/her casual gait and note any instability, drift, sway, and so forth.

Ultrasonic Assessment of Optic Nerve Sheath Diameter

If a patient is unconscious (i.e. does not follow commands or open eyes spontaneously), they may have elevated ICP. There is no reliable test for elevated ICP available outside of a hospital; however, optic nerve sheath diameter (ONSD) measurement is a rapid, safe, and easy-to-perform ultrasonographic assessment that may help identify elevated ICP when more definitive monitoring devices are not available.

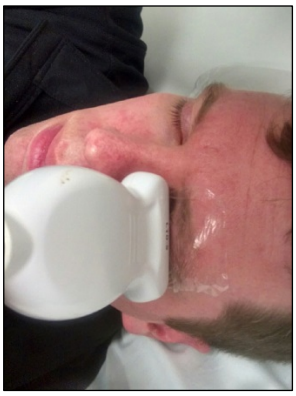
- The optic nerve sheath directly communicates with the intracranial subarachnoid space. Increased ICP, therefore, displaces cerebrospinal fluid along this pathway. Normal ONSD is 4.1–5.9mm.[30]
- A 10–5-MHz linear ultrasound probe can be used to obtain ONSDs. ONSD is measured from one side of the optic nerve sheath to the other at a distance of 3mm behind the eye immediately below the sclera.[31]
- In general, ONSDs >5.2mm should raise concern for clinically significant elevations in ICP in unconscious TBI patients.[5,32] The ONSD can vary significantly in normal individuals, so one single measurement may not be helpful; however, repeated measurements that detect gradual increases in ONSD over time may be more useful than a single measurement.
- ONSD changes rapidly when the ICP changes, so it can be measured frequently.[33] If ONSD is used, it is best to check hourly along with the neurologic examination.

Technique

1. Check to make sure there is no eye injury. A penetrating injury to the eyeball is an absolute contraindication to ultrasound because it puts pressure on the eye.
2. Ensure the head and neck are in a midline position. Gentle sedation and/or analgesia may be necessary to obtain accurate measurements.
3. Ensure the eyelids are closed.
4. If available, place a thin, transparent film (e.g., Tegaderm; 3M, http://www.3m.com) over the closed eyelids.
5. Apply a small amount of ultrasound gel to closed eyelid.
6. Place the 10(–5) MHz linear probe over the eyelid. The probe should be applied in a horizontal orientation (Figure 1) with as little pressure as possible applied to the globe.
7. Manipulate the probe until the nerve and nerve sheath are visible at the bottom of screen. An example of a proper ultrasonagraphic image of the optic nerve sheath can be seen in Figure 2.
8. Once the optic nerve sheath is visualized, freeze the image on the screen.
9. Using the device's measuring tool, measure 3mm back from the optic disc and then obtain a second measurement perpendicular to the first. The second measurement should cover the horizontal width of the optic nerve sheath (Figure 2). An abnormal ONSD is shown in Figure 3.
10. Repeat the previous sequence in the opposite eye. Annotate both ONSDs on the PFC Casualty Card.
11. ONSDs should be obtained, when possible, at regular intervals to help assess changes in ICP, particularly when the neurologic examination is poor and/or unreliable (i.e. with sedation). Serial measurements with progressive diameter enlargement and/or asymmetry in ONSDs should be considered indicative of worsening intracranial hypertension.

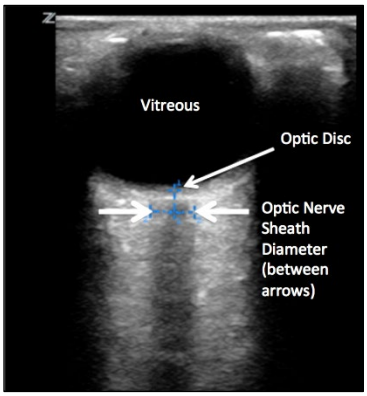
CAUTION: ONSD measurements are contraindicated in eye injuries. NEVER apply pressure to an injured eye.

Figure 1. *Appropriate placement of the linear probe.*



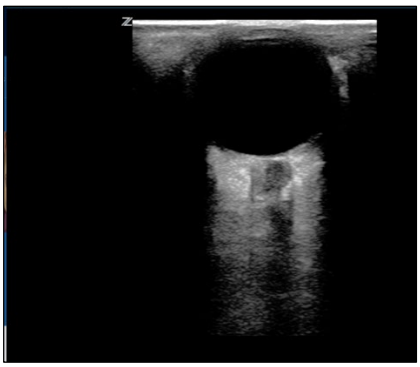
Ultrasound gel is placed over a closed eyelid and the probe placed horizontally over the eyelid, applying as little pressure to the globe as possible. If available, Tegaderm or other thin covering (e.g., Latex glove) should be placed over a closed eyelid for further protection.

Figure 2 *An ultrasonographic view of a normal eye and optic nerve sheath.*



To measure ONSD, apply the ultrasound measuring device to the optic disc and measure back 3mm along the length of the optic nerve. A second, perpendicular measurement is obtained at the previously measured point that spans the horizontal width of the optic nerve sheath. In this image, ONSD was determined to be 5.1mm, a normal value.

Figure 3*. Ultrasound image of the right optic nerve sheath of a 61-year-old man with a traumatic subdural hematoma.*



The optic nerve sheath measured 6.8mm in diameter. Elevated ICP was subsequently confirmed (26mmHg) after the placement of an ICP bolt monitor.

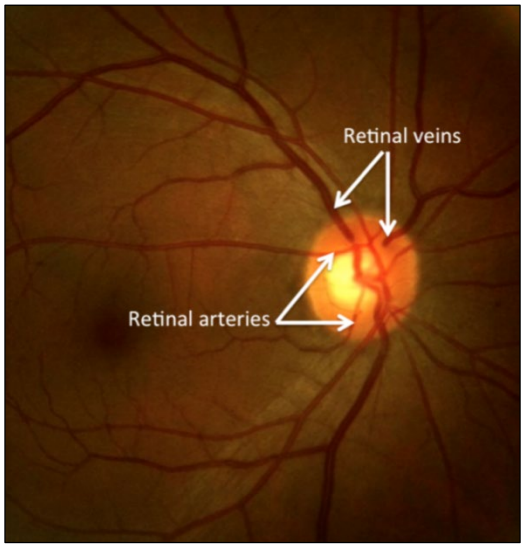
Spontaneous Venous Pulsations

- Spontaneous venous pulsations (SVPs) are subtle, rhythmic variations in retinal vein caliber on the optic disc and have an association with ICP.
- It is difficult to see SVPs without advanced equipment; however, if a handheld ophthalmoscope is available, it is worth an attempt to visualize the retinal veins.
- Don't worry if you cannot see SVPs; this may actually be normal. However, if you do see them, it is very reassuring that ICP is normal.[10]
- If SVPs are initially present and can no longer be seen on subsequent examinations, the provider should be concerned for increasing ICP.

Technique

1. Gently lift the eyelid until the pupil is in view.
2. Using a handheld ophthalmoscope, the provider should maneuver himself or herself to a position where the optic disc can be visualized.
3. Identify the retinal veins as they emerge from the optic disc. Retinal veins are typically slightly larger and darker than retinal arteries. Figure at right demonstrates the typical appearance of the retina.
4. Observe the retinal veins for pulsations. Note the presence or absence of spontaneous venous pulsations
5. Repeat the step 1–4 sequence in the contralateral eye.

Figure 6. Typical appearance of a healthy retina.



The retinal vessels can be seen emerging from the optic disc. Retinal veins can be identified by their slightly larger, thicker size and darker color. Retinal arteries are small, thin, and lighter in color than retinal veins.

Glasgow Coma Scale

TBI severity classification using the GCS score:

- Mild: 13–15
- Moderate: 9–12
- Severe: 3–8

Eye Opening	Verbal Response	Motor Response
4 – Spontaneous 3 – To verbal command 2 – To painful stimuli 1 – No response	5 – Oriented 4 – Confused 3 – Inappropriate words 2 – Incomprehensible sounds 1 – No response	6 – Obeys commands 5 – Localizes to painful stimuli 4 – Withdraws from pain 3 – Flexion to pain 2 – Extension to pain 1 – No response

Richmond Agitation Sedation Scale (RASS)

Score	Term	Description	
+4	Combative	Overtly combative, violent, immediate danger to staff.	
+3	Very Agitated	Pulls or removes tube(s) or catheter(s); aggressive.	
+2	Agitated	Frequent non-purposeful movement, fights ventilator.	
+1	Restless	Anxious but movements not aggressive vigorous.	
0	Alert, Calm		
-1	Drowsy	Not fully alert, but has sustained awakening (eye-opening/eye contact) to voice (≥10 seconds).	Verbal Stimulation
-2	Light Sedation	Briefly awakens with eye contact to voice (<10 seconds).	
-3	Moderate Sedation	Movement or eye opening to voice (but no eye contact).	
-4	Deep Sedation	No response to voice, but movement or eye opening to physical stimulation.	Physical Stimulation
-5	Unarousable	No response to voice or physical stimulation.	

Procedure for RASS Assessment	
1. Observe patient: Patient is alert, restless, or agitated.	Score 0 to+4
2. If not alert, state patient's name and say to open eyes and look at speaker	
- Patient awakens with sustained eye opening and eye contact.	Score -1
- Patient awakens with eye opening and eye contact, but not sustained.	Score -2
- Patient has any movement in response to voice but no eye contact.	Score -3
3. When no response to verbal stimulation, physically stimulate patient by shaking shoulder and/or rubbing sternum.	
- Patient has any movement to physical stimulation.	Score -4
- Patient has no response to any stimulation.	Score -5

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Signs and Symptoms of Elevated Intracranial Pressure

- GCS<8 and suspected TBI
- Rapid decline in mental status
- Fixed dilated pupils(s)
- Cushing's triad hemodynamics (hypertension, bradycardia, altered respirations)
- Motor posturing (unilateral or bilateral)
- Penetrating brain injury and GCS <15
- Open skull fracture

Hypertonic Saline (HTS) Protocol (goal Na 140-165 meq/L)

- 3% HTS: 250-500 cc bolus, then 50 ml/hr infusion, rebolus as needed for clinical signs
- 7.5% HTS: decrease above doses by 50%
- 23.4%: dilute to 3% and use as above. If unable to dilute, can be given as 30 ml bolus and re-dose as needed.
- Central venous line (CVL) preferred for 3% (can be given initially via peripheral IV/IO)
- CVL **REQUIRED** for 7.5% or higher concentration

Military Acute Concussion Evaluation 2 (MACE 2) Form, 2021

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://www.health.mil/Reference-Center/Publications/2020/07/30/Military-Acute-Concussion-Evaluation-MACE-2

MHS Progressive Return to Activity Following Acute Concussion/Mild TBI

Open the attachment on the side menu or open the below link to print or fill out electronically.

https://jts.health.mil/index.cfm/documents/forms_after_action

APPENDIX F: LOGISTICS RESOURCES

Prolonged Field Care – Patient Packaging, 11 Aug 2021

Patient packaging is highly dependent upon the Casualty Evacuation (CASEVAC) / Medical Evacuation (MEDEVAC) platform that is operationally available. If possible, rehearse patient packaging internally and with the external resources. Train with MEDEVAC assets understand transporting teams' standard operating procedures in order to best prepare the patient for transport. (Example some teams want to secure the patient and interventions themselves while others may be okay with a fully wrapped patient).

Ensure the patient is stable before initiating a critical patient transfer. For POI/unstable patients ensure the appropriate transport team (MEDEVAC with en route critical care nurse or advanced provider). Interfacility transfers should meet the following minimum:

1. Hemorrhage control
2. Resuscitation adequate (SBP 70-80 mmHg, MAP >60, or UOP >0.5ml/kg/hr)
3. Initial post-op recovery as indicated
4. Stabilization of fractures

Prepare Documentation

- **Good**: TCCC Card - DA1380
- **Better**: Prolonged Field Care Casualty Work Sheet
- **Best**: PFC Card with TCCC Card and any additional information, reference DA Form 4700 (SMOG 2021) for transport documentation standard

*preference: secure to patient strip of 3in Tape with medications administered attached to blanket or HPMK

Prepare Report

Report should give highlights, expected course, and possible complications during transport. The hand-off is the most dangerous time for the patient it is as important as treatments or medications. If it is rushed things can easily be missed.

- **Good**: Verbal report describing the patient from head to toe with a SOAP note.
- **Best**: MIST (Mechanism, Interventions, Symptoms, Treatments)
- **Better**: MIST with appropriate SBAR (Situation, Background, Assessment, Recommendations) and pertinent labs and other diagnostic information

Prepare Medications

- **Good:** Prepare medication list with doses and time of next dose
- **Better**: Above with additionally preparing next dose of medication for transport crew appropriately labeled.
- **Best**: Above with fresh IV fluids if indicated and fresh bags of drip medications with appropriate labeling and 72 hours of antibiotic for extended transports.

Hypothermia Management

- **Good**: Blankets
- **Better**: Sleep system and blankets
- **Best**: HPMK with Ready Heat or Absorbent Patient Litter System (APLS)

Flight Stressor/ Altitude Management

- **Good**: Ear Protection and Eye Protection, if nothing available sunglasses and gauze may be used, if patient is sedated and intubated eyes can be taped shut
- **Better**: Ear Pro and Eye Pro and blankets in all bony areas, Ear Protection and Eye Protection – foamies or actual hearing protection inserts, goggles
- **Best**: Above with gastric tube (NG/OG) or chest tube for decompression, if indicated. Depending on altitude/platform, consider bleeding air of out bags of fluid.

Secure Interventions and Equipment

- **Good**: Tape (securely tape all interventions to include IVs, IOs, Airway interventions, Gastric Tubes and TQs). Oxygen tanks should be placed between the patients legs and the monitor should be secured on the oxygen cylinder to prevent injury to the patient. Pumps should be secured to the litter
- **Better**: Additional litter straps to secure equipment and extend the litter with back support as indicated for vented patients to prevent VAP.
- **Best**: Above and use the SMEED to keep the monitor and other transport equipment off patient

*if possible, identify with tape the location of interventions or access points on top of hypothermia management to allow transport teams quick identification of location.

Prepare Dressings

Air Evacuation and other MEDEVAC assets do not routinely change dressings during transport; therefore, ensure all dressings are changed, labeled, and secured before patient pick up

- **Good**: Secure and reinforce dressings with tape, date, and time all dressings.
- **Better**: Change dressings within 24 hours of departure, secure as above.
- **Best**: Change and reinforce dressings within 4 hours of departure. Ensure additional Class VIII is available for any unforeseen issues in flight.

Secure the Patient

- **Good**: Litter with minimum of 2 litter straps
- **Better**: Litter with padding (example: AE pad or Sleep Mat) with minimum of 3 litter straps
- **Best**: Litter with padding and flight approved litter headrest with minimum of 3 litter straps (additional litter straps can be used to secure patient or equipment)

Moving a Critical Care Patient

- **Good**: Two person little carry to CASEVAC/MEDEVAC platform
- **Better**: Three person little carry on a rickshaw to CASEVAC/MEDEVAC platform
- **Best**: Four person little carry on a rickshaw to CASEVAC/MEDEVAC platform

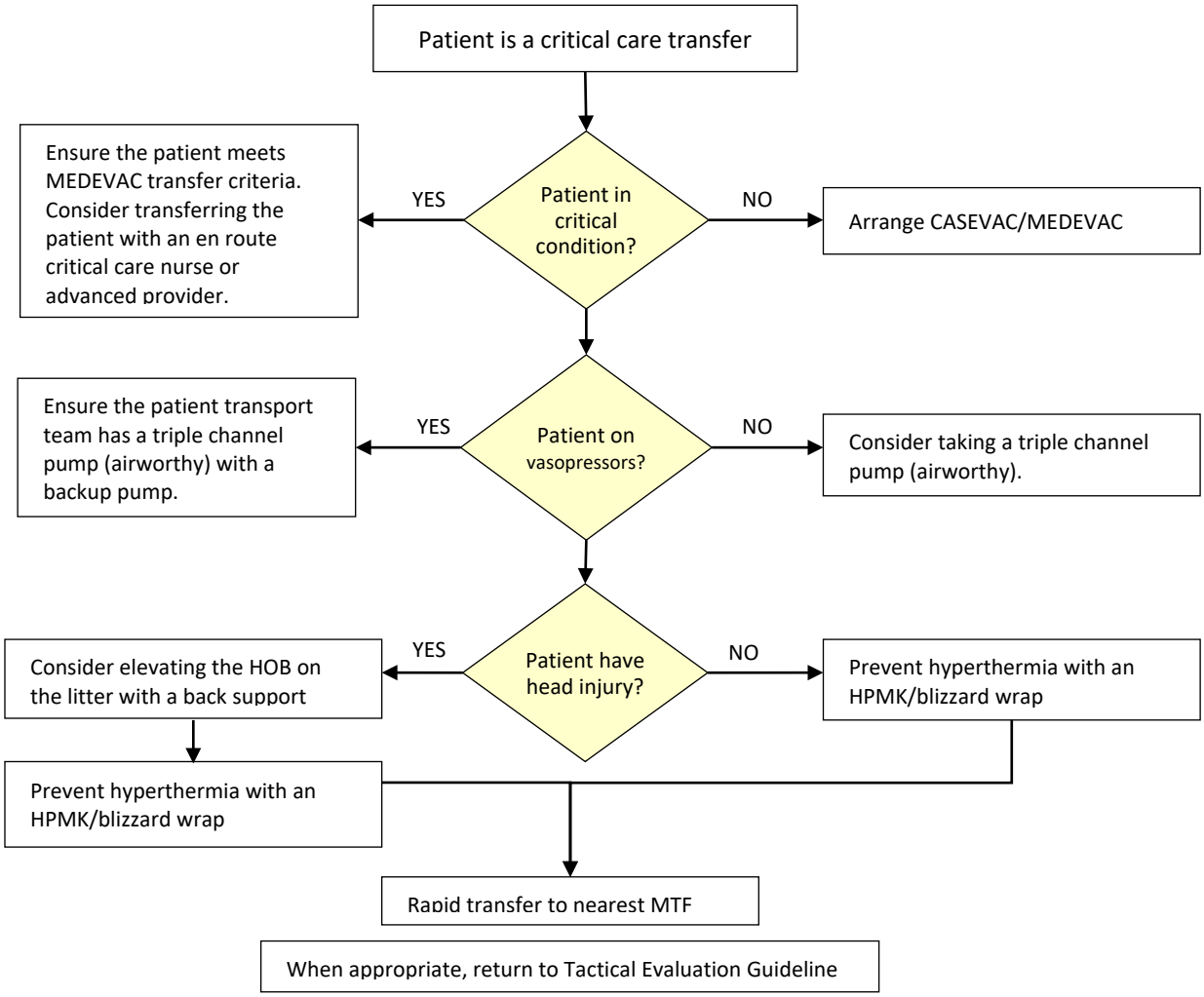
Prolonged Casualty Care Patient Packaging Flowchart

Equipment:

- Litter with at least three litter straps
- Three channel IV pump (airworthy)
- Cardiac monitor and cables
- Suction Device

Possible Complications:

- Inadequate medications
- Injuries not addressed before transport
- Inexperienced provider on flight
- Equipment issues


Patient is a critical care transfer
Patient in critical condition?
YES
Ensure the patient meets MEDEVAC transfer criteria. Consider transferring the patient with an en route critical care nurse or advanced provider.
NO
Arrange CASEVAC/MEDEVAC
Patient on vasopressors?
YES
Ensure the patient transport team has a triple channel pump (airworthy) with a backup pump.
NO
Consider taking a triple channel pump (airworthy).
Patient have head injury?
YES
Consider elevating the HOB on the litter with a back support
Prevent hyperthermia with an HPMK/blizzard wrap
NO
Prevent hyperthermia with an HPMK/blizzard wrap
Rapid transfer to nearest MTF
When appropriate, return to Tactical Evaluation Guideline

Pearls:

- Document all times – TCCC Card or DA4700.
- Assist Ensure the patient is stable before initiating a critical patient transfer.
- POI/unstable patients ensure the appropriate transport team (MEDEVAC W/ECCN or Advanced provider)
- Interfacility transfers should meet the following minimum:
  - Hemorrhage control
  - Resuscitation adequate (SBP 70-80 mmHg, MAP >60, or UOP >0.5ml/kg/hr)
  - Initial post-op recovery as indicated
  - Stabilization of fractures

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Radiology: Imaging Trauma Patients in a Deployed Setting (CPG ID: 01)

Provides general imaging guidelines for Radiologist and Emergency Providers when performing trauma patient assessment in a deployed setting.

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BACKGROUND

Medical imaging plays a critical role in the rapid diagnosis, effective triage, and management of complex poly-trauma patients. High quality medical imaging can be accomplished successfully in a deployed or wartime setting. Due to advances in aggressive resuscitation techniques and the speed of the latest generation Computed Tomography (CT) scanners (64-detector and beyond), rapid trauma scans utilizing CT and Ultrasound (US) imaging can routinely be performed prior to taking the patient to the operating room potentially providing the trauma team with lifesaving information. This Clinical Practice Guideline (CPG) provides an overview of the imaging modalities available in austere settings, the equipment required, and the role that each plays in triaging and diagnosis of the acutely injured poly-trauma patients.

Given the catastrophic injuries sustained by high-energy mechanisms, including high velocity ballistic trauma and blast injuries often seen during the current conflict, rapid diagnosis and treatment is required to optimally treat these critically injured patients. Advances in aggressive resuscitation techniques and the speed of the latest generation Computed Tomography (CT) scanners (64-detector and beyond), rapid trauma scans utilizing CT and Ultrasound (US) imaging routinely allows for imaging to be performed prior to taking the patient to the operating room potentially providing the trauma team with lifesaving information.

Imaging has become a critical component of the care of any patient in the age of modern medicine. The goal of this CPG is to provide guidelines and recommendations for the optimum integration of high quality diagnostic imaging into the treatment and management of casualties with multiple mechanisms of traumatic injuries and how to facilitate the transfer of this information with the patient across the continuum of care.

IMAGING EVALUATION

RADIOGRAPHS

The initial radiographic evaluation of a trauma patient begins with supine Anterior-Posterior (AP) chest and pelvis radiographs taken in the trauma bay usually with a portable x-ray machine. The initial focus being major cardiopulmonary injury and fracture dislocations of the pelvis, the latter can be an indicator of life-threatening internal hemorrhage and/or need for pelvic stabilization.

Fragments

Radiographs can easily demonstrate metallic fragments common in military specific trauma that can be helpful in determining potential sites of injury and injury tracts.

Cervical Spine

Cervical spine radiographic evaluation has been largely replaced by CT and should only be performed when a CT is unavailable. Refer to the JTS CPG, *Cervical and Thoracolumbar Spine Injury Evaluation, Transport, and Surgery in the Deployed Setting*, for further guidance.[1,2]

Extremity Injuries

If extremity injury is suspected, radiographs can be obtained; however, these can be time-consuming and should not delay more diagnostic imaging with CT, if available (Role 3 and above). Additionally with CT, extremity osseous and soft tissue injuries can be easily identified with the added benefit of a lower extremity angiogram as well. See Trauma CT Scan section below.[3]

Retrograde Urethrogram

When there is a clinical suspicion of possible urethral injury, which can occur with significant pelvic fractures or penetrating perineal injury, a retrograde urethrogram may be helpful to further characterize the injury. One field expedient method uses the portable x-ray machine with a single oblique AP scout image of the pelvis. 10cc of contrast is injected into the tip of the urethra through a Foley catheter. While injecting additional contrast through the catheter an image of the pelvis/urethra is obtained in the same slight AP oblique position. This image is typically obtained at the end of an injection of 17-20 cc of IV contrast but prior to the completion of the injection to insure full luminal distention with contrast.

Equipment

A variety of portable x-ray units are utilized in theater at Role 2 and Role 3 facilities. Many of the portable units, especially at the Role 2, have limited ability to penetrate (limited range of kVp and mAs) soft tissues. Obtaining lateral views generally requires penetrating a greater thickness of soft tissue, particularly in large patients, and often produces very limited quality images. AP projection images should be adequate on most portable units, but will rely upon the x-ray technician to optimize technique to maximize image quality.

Radiation Safety

Members of the trauma team should have lead aprons and thyroid shields available near the trauma bay. In ideal situations, trauma team members will don the lead shielding beneath other personal protective equipment prior to patient arrival. Distance is also protective from radiation exposure. If feasible based on the patient's condition, any personnel without lead shielding should move a short distance (recommended minimal distance 6 feet) away from the x-ray unit. Cross table lateral images produce a much higher level of radiation exposure to personnel in the trauma bay and nearby areas and should only be obtained when absolutely necessary.

Radiation certainly remains a concern during the performance of all imaging particularly with CT. The radiologist should carefully monitor mAs and kVp settings such that dose is minimized while achieving sufficient diagnostic image quality.

FOCUSED ABDOMINAL SONOGRAPHIC ASSESSMENT FOR TRAUMA (FAST) EXAMINATION

While the FAST scan has been validated only in hemodynamically unstable blunt trauma patients, it has become a standard tool in the trauma bay and Emergency Department (ED) in most trauma patients.[4] It is now considered an adjunct to the primary survey in Advanced Trauma Life Support (ATLS) guidelines, ninth edition.[5] It has also come into use for hemodynamically stable patients and penetrating trauma in the deployed setting where CT scans are not readily available. If positive, these scans provide quick information that can aid trauma surgeons in triaging patients, either to the Operating Room (OR) or to further imaging. FAST in combat trauma

has a sensitivity of only 56% and specificity of 98%.[6] Routine use of the FAST in trauma patients allows for a consistent evaluation strategy while maintaining the skills of providers. A negative FAST cannot be relied upon to rule out injury, especially in penetrating trauma.

Diagnostic Peritoneal Lavage (DPL)

In the absence of a CT scanner, DPL should be considered in determining need for laparotomy in trauma patients. It has largely been supplanted by the FAST exam (and is considered an optional skill in the current edition of ATLS). DPL remains the most sensitive test for hollow viscus injury and mesenteric injury, and retains its usefulness in the unstable patient with a negative or equivocal FAST exam. DPL is 100% accurate for intrabdominal injury in these patients.[7] One must consider the additional time that this diagnostic test may require, and should not delay immediate surgical intervention in patients that have mechanisms concerning for intra-abdominal trauma and remain unstable despite resuscitative measures.[8]

Role of the Radiologist

At the Role 3, properly trained providers including radiologists, surgeons and emergency physicians, can perform and interpret FAST scans in the ED on a hand held portable US device. The utility of radiologists performing the exams would be to free up emergency providers and surgeons to either perform other assessments or interventions, or care for additional patients in the trauma bays. While in the trauma bay, the radiologist would also be available to provide preliminary interpretations of the portable chest x-ray/pelvis exams on the digital portable machines. However, once CT scans begin to be obtained on the trauma patients, the emergency physicians and surgeons would primarily perform the FAST scans and interpret plain radiographs at the bedside.

Equipment

The examination is performed with a portable hand-held machine most commonly using a standard 3-7 MHz curved array US probe. A phased array probe is also acceptable, and occasionally is preferred if cardiac or pulmonary imaging is necessary. Real-time imaging is performed without the necessity of saving static images.

Standard Examination

The standard FAST examination is focused on evaluating for the presence of free intraperitoneal fluid in:

1. The right upper quadrant between the liver and kidney,
2. The left upper quadrant between the spleen and kidney, and;
3. The pelvis at the level of the bladder.
4. An evaluation for cardiac activity and hemopericardium/tamponade should also be performed by placing the probe in the subxiphoid location and aiming towards the patients left shoulder.[4]

Additional Examinations

The cardiac portion of the exam can rapidly identify cardiac injury, evaluate cardiac function and give information about the success of resuscitation.[9] In the case of massive exsanguination; the examination should be rechecked for free fluid after blood is given. A clot identified within a ventricle indicates prolonged asystole and may aid in the decision to terminate efforts. Pneumothorax or hemothorax may also be identified by placing the probe along the chest wall and looking for the presence of lung sliding. Loss of sliding implies the possible presence of a pneumothorax.[10]

TRAUMA CT SCAN

If at all possible given the patient's clinical stability, a trauma CT can be performed before going to OR. Often indications for surgical intervention are already present; however the CT scan can provide additional information to the surgeon, identifying unsuspected and potentially clinically significant injuries. Given the relatively small footprint of most Role 3 facilities the patient can be taken to the OR immediately following the acquisition of the CT scan, with the radiologist providing the pertinent findings to surgeons while in the OR. For clinically unstable patients, this trauma CT can be obtained after continued resuscitation and surgical intervention in the OR.[11]

CT Protocol (Adult)

. Initial acquisition includes non-contrast CT through head and face (to include the entire mandible), at 1 mm axial slice thickness which allows for isotropic sagittal and coronal reformatted images. This scan is followed by a contrast enhanced CT from the level of the circle of Willis through the bottom of the pelvis. Alternatively in the setting of significant lower extremity trauma such as dismounted complex blast injury, the scan can be performed through the lower extremities (default through the feet) allowing evaluation of skeletal and vascular injury of the lower extremities. A discussion with the trauma team should be performed prior to the scan to establish the inferior extent of the scan coverage. Of course, additional information including long bone fractures and metallic fragments can be seen on the scout image, which may alter the scan coverage to include those areas. Some difficulties may arise if the patient is tall and the CT gantry movement does not allow coverage through the lower extremities, however this can be ameliorated by scanning from the head to as low as possible, then either physically sliding the patient up on the gantry or rotating them 180 degrees on the gantry table and scanning through the remainder of the legs.[11-13] See Appendix A for more information.

CT Review

3D workstations are a required resource in any civilian trauma center and are a required resource for any Role 3 where major casualties are expected. These workstations allow the radiologist a rapid overview of injuries and ability to zoom into abnormalities. Additionally these powerful workstations allow for rapid creation of detailed 3D shaded surface and multiplanar reconstructions that facilitate a broad overview of numerous soft tissue and osseous injuries at different locations and accentuate the location of fragments. Utilizing these shaded bone or skin surface and Multiplanar Reconstruction (MPR) images can be very helpful for injury tract analysis. The workstation also enables focused arterial vascular analysis, thus supporting early identification of more subtle vascular injuries that can have a significant clinical impact on patient morbidity and mortality.[13] In mass casualty situations, a modified workflow may be necessary. The performance of preliminary readings or "wet reads" may be required, especially when there is a sole radiologist present.

IV Access for CT

18g antecubital IV is typically desired – if placed on a medical evacuation platform prior to arrival, the cannula must be thoroughly rechecked/flushed to ensure function and avoid contrast extravasation. More distal upper extremity IVs should typically not be used due to the risk of extravasation and compartment syndrome. A central line can be used for contrast power injection. A large lumen resuscitation catheter such as those utilized for the rapid infusion device (normally rated up to 9cc/sec) can usually handle contrast injection.[14] Ensure that the correct size catheter lumen is utilized for the power injection as the catheter will often have various sized lumens. The largest lumen of catheter would be the best to handle the power injection. Of course, should the rapid infusion device be used to infuse fluid/blood products at the same time, it should be turned off during the injection to avoid dilution of the contrast with the instillate. Current intraosseous needles should not be used for contrast administration. Though a few case reports of individual patients undergoing CT examination with contrast injection through IO needles have been published, larger studies in trauma patients are needed to establish efficacy, adverse effects, and bolus timing modifications.

CT Contrast Injection

The goal of the injection is to provide concurrent solid organ enhancement, arterial enhancement, and pulmonary arterial. Typical doses are approximately 150 cc of Isovue 300 or 340 contrasts utilizing a dual phase injection – 80cc at 1.4 cc/sec, followed immediately by 70cc at 3.5 cc/sec for the pan scan. The scan is started 2-3 seconds before the completion of the contrast injection to maximize pulmonary arterial filling. For pediatric injection volume and rates by weight, see Appendix B.

Rectal Contrast

This can be helpful when evaluating penetrating flank injuries or possible rectal involvement below the peritoneal reflection from pelvic injuries. One may utilize 1L of saline/water with the addition of 1 bottle (50ml) of IV contrast. A Foley catheter is used to cannulate the rectum and the balloon is instilled with saline. In the setting of significant rectal or perineal trauma the surgeon may need to place the Foley catheter in the rectum.[16]

Delayed Images

Routinely performed for further evaluation of identified solid organ injury, identify active extravasation or pseudoaneurysm formation, which can aid surgeons in grading the solid organ injury. Additionally, contrast excretion within the ureters and subsequently into the bladder can also aid in diagnosis of injuries to these structures.

CT Cystogram

50 cc of IV contrast diluted into 500 cc of saline is infused through the indwelling urinary catheter. A minimum of 300 cc and up to 500 cc of this dilute contrast material should be infused to provide adequate evaluation of the integrity of the bladder wall. The catheter is then clamped for the CT examination. This type of exam is performed following the routine trauma CT with 1mm thick images acquired through the pelvis with the bladder filled. If necessary, additional axial imaging of the bladder can be performed following the drainage of the contrast to detect more subtle extraperitoneal bladder injuries which may be obscured by the distended bladder.[17]

CT Language Settings

Become familiar with the languages available/preloaded on the scanner for breathing instructions, which often include: English, French, Spanish, Japanese, and Chinese. Using interpreters available in your facility, record the same instructions in commonly encountered languages of coalition partners and host-nation patients (e.g., Arabic, Pashtun, Dari, Farsi, Georgian, Italian, Danish, Estonian, etc.). Ensure to select the correct language at the time of scan setup for each patient. Using these instructions will improve image quality for conscious patients.

MILITARY WORKING DOGS (MWD)

Given the nature of military operations in the current conflict, MWDs have sustained similar injuries to dismounted soldiers and will need CT trauma scans as well.[18] These examinations will typically be performed in consultation with veterinarians who will sedate the dog as necessary for the scan. However in an emergency situation, it may be necessary for the radiologist to perform the scan. Given this eventuality, prior coordination between the radiologist and veterinarian is essential. Utilize a scanning protocol based on the pediatric settings to include the doses of and rates of contrast administration. Refer to the JTS CPG, *Clinical Management of Military Working Dog*[18] and Appendix B for further details.

IMAGE TRANSFER

All patients evacuated through casualty evacuation should have images sent electronically ahead of time as well as have a CD created to send with the patient as a backup. Although at times trauma patient's true name may not be known during the initial evaluation, it should be stressed that usually it becomes known sometime soon thereafter. Ensuring the patient's information is updated with the real name rather than a local hospital's trauma name will ensure those studies are available for review through the health care evacuation system.

MRI

While MRI has been deployed to theater in the past, its utility in the acute management of combat trauma has not been established. Refer to the JTS CPG *Use of MRI in Management of mTBI in the Deployed Setting*.[19]

PERFORMANCE IMPROVEMENT (PI) MONITORING

INTENT (EXPECTED OUTCOMES)

All trauma patients arriving at a Role 3 hospital will receive proper and expeditious radiologic screening of injuries.

PERFORMANCE/ADHERENCE MEASURES

Identify missed injuries with appropriate radiographic imaging and/or reading.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- Theater Image Repository

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: DETECTOR TRAUMA CT PROTOCOL

TRAUMA CT PROTOCOL

1. Unenhanced spiral brain 1.25mm (bone and soft tissue algorithm); 5mm reconstructions immediately available for review.
2. Circle of Willis to symphysis (bone and soft tissue algorithms).
    - 150ml biphasic contrast injection – initial 65ml at 2ml/sec then 85 ml at 3.5ml/sec Scan starts at 60 sec
    - This gives both portal venous enhancement with good arterial contrast at the same time and the scan can be carried on down to the legs/feet is necessary. The cervical contrast has been very useful both for penetrating injury and for spinal injury/vertebral artery injury.
3. The use of delayed scans limited to specific cases at the request of the radiologist.

64 DETECTOR TRAUMA CT PROTOCOL

1. Unenhanced helical brain 1.25mm (bone and soft tissue algorithm); 3mm reconstructions immediately available for review.
2. Circle of Willis to symphysis 1.25mm (bone and soft tissue algorithms); 3 to 5mm reconstructions immediately available for review.
    - 150mL biphasic contrast injection – initial 80cc at 1.4 cc/sec then 70cc at 3.5 cc/sec
    - Scan starts 3 sec before the completion of the contrast injection.
3. This gives both portal venous enhancement with good arterial contrast at the same time and the scan can be carried on down to the legs/feet is necessary. The cervical contrast has been very useful both for penetrating injury and for spinal injury/vertebral artery injury.
4. The use of delayed scans limited to specific cases at the request of the radiologist.

16 DETECTOR TRAUMA CT PROTOCOL

1. Unenhanced helical brain 1.5mm (bone and soft tissue algorithm); 3mm reconstructions immediately available for review.
2. Circle of Willis to symphysis 1.5mm (bone and soft tissue algorithms); 5mm reconstructions immediately available for review.
    - Arterial phase imaging – 150mL single arterial phase contrast injection at 3.5 cc/sec.
    - Automatically triggered with a threshold of 100 HU at the level of the aortic arch.
3. The arterial phase imaging alone is preferred due to the technical limitations of the scanner.
4. The use of delayed scans limited to specific cases at the request of the radiologist.

APPENDIX B: 64 DETECTOR PEDIATRIC (MWD) IV CONTRAST INJECTION PROTOCOLS

CHILD WEIGHT (kg)	VENOUS PHASE RATE/VOLUME	ARTERIAL PHASE RATE/VOLUME	TOTAL CONTRAST DELIVERED
5	0.2sec/7mls	0.4sec/3mls	10
10	0.3sec/14mls	0.6sec/6mls	20
15	0.4sec/20mls	0.8sec/10mls	30
20	0.5sec/26mls	1.0sec/14mls	40
25	0.6sec/33mls	1.3sec/17mls	50
30	0.7sec/40mls	1.6sec/20mls	60
35	0.8se/47mls	1.8sec/23mls	70
40	0.9sec/53mls	2.1sec/26mls	80
45	1.0sec/60mls	2.2/30mls	90
50	1.2sec/66mls	2.4sec/34mls	100
55	1.3sec/73mls	2.6sec/37mls	110
60	1.4sec/80mls	2.8sec/40mls	120
70	1.6sec/94mls	3.3/46mls	140
COLOR CODED PEDIATRIC DOSE SETTINGS (mA/kV)			
Pink	6.0 - 7.5 kg	59.5 - 66.5 cm	
Red	7.5 - 9.5kg	66.5 - 74 cm	
Purple	9.5 - 11.5kg	74 - 84 cm	
Yellow	11.5 - 14.5kg	84.5 - 97.5 cm	
White	14.5 - 18.5kg	97.5 - 110cm	
Blue	18.5 - 22.5kg	110 - 122cm	
Orange	22.5 - 31.5kg	122 - 137cm	
Green	31.5 - 40.5kg	137 - 150cm	
Black	40.5 - 55 kg	< 150 cm	

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) for Hemorrhagic Shock (CPG ID:38)

Reviews the range of accepted management approaches to profound shock and post-traumatic cardiac arrest and establishes indications for considering REBOA as a hemorrhage control adjunct.

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PURPOSE

This CPG reviews the range of accepted management approaches for Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) as a hemorrhage control adjunct in traumatic shock and post-traumatic cardiac arrest in combat casualties. Updated guidelines exist for the use of REBOA in the civilian clinical setting. The use of REBOA in the military setting is less well defined. Prior CPGs relied heavily on expert opinion and consensus from military thought leaders. Civilian guidelines currently apply to well-resourced civilian centers with expertise in trauma care. Recommendations for use in the military setting must consider the unique challenges of the deployed environment. Mission parameters, tactical situation, casualty's physical location and evacuation capability also determine the capabilities available for combat casualty care. Mechanisms and patterns of injury, and the availability and experience level of surgical resources and resuscitation teams all influence the care rendered on the field. The optimal management is best determined by the clinician at the bedside. This document does not address the use of REBOA for indications other than trauma and traumatic hemorrhage.

BACKGROUND

- Hemorrhage continues to be a leading cause of preventable death on the battlefield. It can be broadly categorized as compressible or non-compressible depending on its location. Non-Compressible Torso Hemorrhage (NCTH) arises from trauma to the torso vessels, pulmonary parenchyma, solid abdominal organs, or the bony pelvis.[1] Because NCTH is not amenable to control by direct pressure or extremity tourniquet application, it is particularly lethal.[2]
- Resuscitative Aortic Occlusion (RAO) affords distal hemorrhage control while increasing cardiac afterload and thereby maintaining coronary and cerebral perfusion pressure until direct hemostasis can be achieved.[3] RAO has traditionally required a left thoracotomy or laparotomy for aortic exposure.[4-7] Resuscitative thoracotomy has a high mortality rate, due largely to the nature of the injuries leading to arrest.[8-10] Nonetheless, data from combat theaters indicate that there is a reasonable probability of long-term survival and recovery following RAO in appropriately selected casualties as described in the JTS Emergent Resuscitative Thoracotomy (ERT) CPG.[11-13]
- There is no high grade evidence defining the specific indications for REBOA, nor that REBOA improves survival or outcomes as compared to ERT.[14] There is literature demonstrating both a survival benefit with REBOA [15-16] as well as data suggesting that REBOA may actually worsen mortality.[17-18] The advent of the wireless ER-REBOA and a better understanding of REBOA indications has led to recent studies demonstrating the non-inferiority of REBOA. In patients that do not require CPR, REBOA has now shown a survival benefit.[19-23] In the highest quality prospective analysis available, REBOA improved survival beyond the emergency department and to hospital discharge compared to ERT when applied prior to traumatic cardiac arrest in patients with hemorrhagic shock.[23]
- REBOA is an alternative form of RAO for patients at risk of imminent cardiovascular collapse. It is performed through a femoral artery approach without the need for thoracotomy. REBOA is best applied prior to cardiovascular collapse when the site of hemorrhage is below the diaphragm and no open thoracic intervention is otherwise indicated.[23]
- ERT allows management of thoracic injuries and manual cardiac compression and thus remains the procedure of choice for patients with significant thoracic or cardiac injury. REBOA has been used in

combination with open thoracotomy and/or sternotomy as a resuscitative bridge to open surgical control of hemorrhage to treat thoracic great vessel injury.[24]

CURRENT RECOMMENDATIONS

- For the purpose of this CPG, REBOA remains contraindicated in the setting of major thoracic hemorrhage or pericardial tamponade.
- ERT may improve cardiac index as well as coronary and cerebral perfusion pressure compared to closed chest compression.[26] However, when closed chest compressions are combined with REBOA, cardiopulmonary resuscitation is more effective allowing for higher EtCO2 and cardiac compression fraction compared to open cardiac massage and aortic cross clamping.
- RAO poses a significant risk of life-threatening and limb-threatening complications. RAO is a time-critical intervention that should never be undertaken without expedient access to definitive hemorrhage control.[1–19,7-28,14,17,20]
- The major rate limiting step with REBOA is accurate and expedient common femoral artery (CFA) access. Ultrasound guided access is the preferred method for CFA access however, up to 50% of cases require open exposure. Smaller access sheaths are associated with improved outcomes.[29-32]
- Initial animal experiments demonstrated the potential merits of REBOA with occlusion times of up to 90 minutes.[33-34] However, long occlusion times resulted in nonsurvivable metabolic derangements and organ damage. These side effects were significantly lessened with occlusion times less than 30 minutes.[35]
- Outcomes for Zone 1 REBOA are optimized if occlusion times are between 15-30 minutes (See Appendix C for an illustration of the Zones of the Aorta). Occlusion times over 30 minutes are associated with higher ischemic complications and higher mortality.[17]
- Outcomes for Zone 3 REBOA are optimized if occlusion times are 30-60 minutes, though survival following longer occlusion times has been reported.[36]
- The American Association for the Surgery of Trauma (AAST) prospective Aortic Occlusion for Resuscitation in Trauma and Acute Care Surgery (AORTA) database contains cases with occlusion times exceeding the above recommendations, but this registry does not track the use of occlusion techniques such as intermittent and/or partial REBOA.[41] Partial and intermittent balloon techniques may reduce distal ischemia and extend tolerable occlusion times.[37-40] There is currently insufficient data to guide any consensus on this practice.[42,36]
- With increasing REBOA availability and provider experience, REBOA has successfully been utilized in multiple austere military locations.[43-47] In austere resuscitations, REBOA has been shown to improve the ability to triage multiple casualties, allow for blood product conservation, and assist in creating a 'bloodless' environment for damage control surgery.[45,47-48]
- Properly trained nurses are responsible for assisting in equipment availability and setup, accurate documentation and recording of catheter insertion distance in addition to safe and accurate patient handoff during transfer/transport.
- The implementation of this technique must be determined at each site based on training, experience, local resources, and evacuation timelines.

- Documentation of Aortic Occlusion via open thoracotomy or REBOA will be done using the Aortic Occlusion (AO) Procedure Note that is found in Appendix H of this CPG

REBOA IN TRAUMATIC ARREST & PROFOUND SHOCK

Indications for the use of REBOA are summarized below. These indications mirror the indications for resuscitative thoracotomy with the exception that shock or arrest secondary to penetrating chest trauma is a relative contraindication to REBOA (See the JTS Emergency Resuscitative Thoracotomy, 18 Jul 2018 CPG [13] As stated above, there is no high grade evidence defining the specific indications for REBOA. Data is, at best, mixed when comparing survival and outcomes of REBOA versus ERT.[14,23] However, there is at least one major trial that demonstrates that REBOA improves survival beyond the emergency department as well as to hospital discharge when compared to ERT for patients who are in hemorrhagic shock, but are pre-cardiac arrest.[23] For this reason, early recognition of hemorrhagic shock is vital when identifying patients who may benefit from REBOA.

INITIAL MANAGEMENT

Initial management priorities for patients with traumatic arrest or impending arrest include early control of hemorrhage and hemostatic resuscitation as described in the JTS Damage Control Resuscitation CPG. [50] The initial focus in patients presenting in profound hemorrhagic shock, to include loss of pulses, is to determine the best resuscitative strategy, and whether resuscitation is appropriate or futile in a moribund patient. The following must be rapidly determined:

- Mechanism and pattern of injury
- Presence of a pulse
- Duration of cardiac arrest
- Presence or absence of an organized, narrow complex cardiac rhythm and/or organized cardiac activity by ultrasound.
- Resources available
- Number of concurrent casualties

Patients exsanguinating from abdominal, pelvic, or junctional lower extremity bleeding may be candidates for REBOA. Such patients are identified by penetrating mechanism of injury to abdomen or pelvis, blast or blunt mechanism with positive FAST or suspected pelvic fracture, or massive proximal lower extremity trauma with signs of impending cardiovascular collapse.

Exsanguinating hemorrhage in the chest must be ruled out prior to placing REBOA—this can be done with chest tube placement, thoracostomy, x-ray, or thoracic ultrasound. In cases of major chest hemorrhage, occlusion of the aorta may increase thoracic bleeding and is thus best addressed via thoracotomy or sternotomy.

A decision algorithm for Resuscitative Aortic Occlusion (RAO) is found in Appendix A. If RAO is performed, concurrent hemostatic resuscitation and closed chest cardiac massage should continue while the procedure is performed.[51] If RAO is not performed, resuscitative efforts should cease unless there is a compelling reason to consider a non-traumatic arrest.

RESUSCITATIVE THORACOTOMY

The gold standard for aortic occlusion in traumatic arrest remains a left anterolateral thoracotomy (See JTS Emergent Resuscitative Thoracotomy CPG.)

TRANS-ABDOMINAL AORTIC OCCLUSION

The aorta can also be occluded trans-abdominally at any point along its length. It can be occluded with either application of a clamp or compression with a retractor or manually. Alternatively, balloon occlusion can be considered (below) as this can decrease instruments in the upper abdomen, depending on where the focus of bleeding is located. In obese patients with a large volume of hemoperitoneum or other intra-abdominal pathology, a trans-thoracic approach or a balloon approach to the aorta may be preferable. As with all other forms of RAO, restoration of aortic perfusion should be carefully coordinated with the rest of the team to minimize the effects of reperfusion and blood volume shifts.

REBOA STEPS

REBOA can be considered in 6 sequential steps:

1. Arterial access and positioning of sheath
2. Positioning of the balloon
3. Inflation of the balloon
4. Operative/procedural control of bleeding
5. Deflation of the balloon
6. Sheath removal

REBOA can be performed preemptively in patients with high-risk injury patterns and unstable physiologic parameters as described above. In this way, REBOA can be proactive rather than reactive in appropriate patients. The indications for REBOA are summarized in Appendix A for traumatic arrest and Appendix B in cases of profound shock. A schematic of the aortic anatomy is presented in Appendix C.[52] If proximal aortic occlusion is required, this is termed Zone 1, whereas distal aortic occlusion is termed Zone 3. Zone 1 REBOA deployment will be used in most patients presenting with hemorrhagic shock, and may be used in all patients with traumatic arrest, regardless of injury pattern, due to the benefits on a patient's mean arterial pressure (MAP).[53]

In clinical situations where REBOA is being considered, pre-emptive placement of an arterial line in the common femoral artery (CFA) is recommended. CFA access has consistently been identified as the rate limiting step to REBOA deployment.[30] Obtaining early CFA access in the form of an arterial line can greatly decrease REBOA placement time as a preplaced common femoral arterial line can quickly be re-wired to a REBOA introducer in the event of patient deterioration.

Preclinical research has shown a Zone 1 aortic occlusion time of 60 minutes or more results in significant metabolic derangement and organ damage that may offset any gain obtained by early hemorrhage control. 30 minute occlusion times had significantly improved outcomes without evidence of severe physiologic costs. Based on this data, Zone I REBOA should be deployed for no greater than 30 minutes. Zone III REBOA historically has been considered acceptable for up to 4-6 hours.[54-55] However, recent analysis in preclinical models have led to the revised recommendation to target Zone III balloon occlusion times of less than 30, and no greater than 60 minutes.[54-56,36]

After placing a REBOA, careful management of the femoral sheath is imperative. The majority of complications associated with REBOA use are related to the sheath and access site complications. Reported femoral access complications include arterial disruption, dissection, pseudoaneurysms, hematoma, thromboembolic phenomenon, and extremity ischemia. These complications have resulted in limb loss.[27,28] Due to the risk of sheath dislodgement or vessel wall damage excessive patient movement should be avoided. Patients with indwelling sheaths should be positioned supine or reverse Trendelenburg only. If the patient must be moved or turned, they should be kept in a flat position and log-rolled.

The provider, or assistant, should promptly document placement time, pre-/post-placement blood pressure and MAP, and REBOA insertion distance. Please use the Aortic Occlusion (AO) Procedure Note that is found in Appendix H of this CPG for specific REBOA documentation. It is also available on the JTS Website at https://jts.health.mil/index.cfm/documents/forms_after_action - under CPG Forms. Balloon volume and inflation time should be noted at the insertion site for reference by all providers caring for the patient. The provider is responsible for prevention of catheter migration, particularly during patient transport. A provider who is knowledgeable about the management of REBOA should attend to the patient while awaiting definitive surgical repair, to include during transport. The trained provider is responsible for ensuring a safe and competent hand off.

While the sheath is in place, hourly neurovascular assessments of the bilateral lower extremities should be completed. These assessments should continue for 24 hours after removal of the sheath to allow for early identification and intervention of access site complications. In addition, follow-on duplex imaging (24-48 hours post REBOA) of the access site allows for early identification and treatment of any access site complications. This may be performed either at the Role 3 facility or as soon as possible after arrival at a Role 4 facility, depending on resources available to perform and interpret the ultrasound.

Once definitive hemorrhage control has been obtained, the REBOA sheath should be removed and 30 minutes of direct pressure applied to the CFA access site. If arterial pressure monitoring is still required an alternate line site should be considered. An angiogram through the sheath to document distal limb perfusion is best practice, though not always available. If a large sheath size is used, a patient is coagulopathic, or there is technical difficulty in sheath removal a cut down and arterial repair, patch or graft may be required. This may be best accomplished in the Role 3 environment with access to specialists and/or surgical backup.[21]

The balloon should be deflated once specific vascular control or definitive hemorrhage control has been obtained. Communication with the assistant holding the apparatus securing the catheter and the anesthesia team is critical before consideration of deflating the balloon. When deflating the balloon turn the three-way stopcock and withdraw saline slowly and deflate the balloon slowly as this step can be anticipated to result in a significant decrease in afterload and hypotension and may result in cardiac collapse. Additional resuscitation may be needed while the balloon is slowly deflated. After balloon deflation, the team should anticipate hemodynamic changes related to reperfusion, washout of metabolic byproducts, and acidosis. As such, intermittent balloon inflation and deflation may be necessary during ongoing resuscitation until hemodynamic stability is restored.

Even in an austere environment, protocols for use and follow on care should be planned and discussed prior to implementation. Team training and awareness of pitfalls are critical to ensure the best possible outcomes.

If definitive hemorrhage is not obtained, leaving the sheath in place without aortic occlusion may be a valid option. By leaving the sheath in place, the REBOA can easily be reinserted and aortic occlusion can quickly be obtained if rebleeding occurs or hemorrhage continues.[38] In general, and situation/resource dependent, the sheath should be left in during any active or ongoing resuscitation. The sheath should not be removed immediately prior to transport, and is best removed where vascular complications can be treated and managed.

A sheath MUST NEVER be left in for transfer to a host nation facility.

AEROMEDICAL EVACUATION CONSIDERATIONS

Patients who receive REBOA at a Role 2 and need to be evacuated to a higher level of care should have hemorrhage control addressed and balloon deflated prior to transfer. Under no circumstance should a Zone 1 REBOA remain inflated during transport. In rare situations when a short-distance rotary-wing evacuation to higher level of care is possible, a Zone 3 REBOA inserted at Role 2 may remain inflated during transport however this requires exceptional communication and planning to avoid undue risk of ischemic injury.

If rotary-wing transport is available, a medical provider trained in hemodynamic monitoring and manipulation of the occlusion balloon should accompany the casualty at all times. If a REBOA sheath is in place in a trauma patient, re-placement/re-inflation of the balloon during transport is an option for trained providers in the event of sudden profound hypotension. Simultaneous blood transfusion is needed and balloon inflation time should not exceed 15 min in Zone I.

The essential equipment for REBOA is provided in Appendix D while the appropriate technical steps and considerations are summarized in Appendix E.

TRAINING

Prior to using REBOA, providers should have a thorough knowledge of the device, its indications, use and potential complications. Organized, curriculum-based REBOA training courses such as the American College of Surgeon's Basic Endovascular Skills for Trauma (BEST) course or the 'Resuscitation Adjuncts: Prehospital Transfusion & REBOA' (RAPToR) Course are available. Successful completion of a REBOA training course, including a didactic and hands on skills component, is recommended prior utilization of the device. Skills training can be achieved through high-fidelity simulation, perfused cadaver or live tissue training. Critical skills include access to the CFA with ultrasound and cut down, sheath placement and positioning, and REBOA operation and removal. Anatomically correct models are critical for accurate training of CFA access skills, and thus perfused cadavers are recommended to meet this requirement.[57-59]

Ultimately, the decision to perform REBOA on patients at high risk for hemorrhagic death will depend on the specific injury pattern, individual provider experience, team training, and local resources.

REBOA USE BY NON-SURGICAL RESUSCITATION TEAMS

Advanced resuscitation teams may be utilized in austere environments as a bridge to surgical hemorrhage control. Data on the effectiveness of this approach are lacking. REBOA in this setting may be considered in the rare circumstance that all of the following conditions are met:

1. The casualty would otherwise die in 15-30 minutes without REBOA (NCTH, refractory hemorrhagic shock)

2. A physician experienced in REBOA therapy is present

3. Blood product resuscitation, preferably whole blood, is available but failing to resuscitate the patient

4. Time to definitive hemorrhage control is short (ideally <15 min Zone 1, <30 min Zone 3).

The narrow therapeutic window of aortic occlusion is the major limitation of REBOA. Techniques for lengthening aortic occlusion time are being investigated such as partial REBOA (pREBOA), intermittent REBOA (iREBOA), regional hypothermia, and pharmacologic interventions to decrease ischemia or enhance ischemia resistance. Multiple descriptions of pREBOA and iREBOA techniques in animal models have been described. One protocol recommended by the Committee on Tactical Combat Casualty Care (CoTCCC) describes iREBOA as an initial 15min of occlusion time, followed by balloon deflation and reassessment of the patient's systolic blood pressure (SBP). If SBP > 80mmHg, the balloon should remain deflated. If SBP drops to $\leq$ 80mmHg the balloon should be re-inflated. If the SBP dropped below 80mmHg in less than 3 minutes, balloon occlusion will be maintained for up to 30 min as resuscitation continues. If decompensation occurs after 3 minutes, the balloon should re-inflated and deflated again after 10 minutes for reassessment. This cycle continues for a total occlusion time up to 120 min or until the patient's blood pressure remains stable above 80mmHg. iREBOA has come under criticism due to multiple limitations of the initial study and lack of other supportive studies.[37-38,42,60]

REBOA PITFALLS

- Making the decision to perform REBOA too late. Mortality is high after loss of pulses has occurred, as it is with ERT.
- Difficulty locating the common femoral artery in the groin. The clinician must be very familiar with open, percutaneous, and ultrasound guided femoral access techniques. Early CFA access is recommended even if REBOA not utilized.
- Insertion of the REBOA too low, below the femoral artery bifurcation. The catheter should be placed in the common femoral artery, just below the inguinal ligament. Insertion into the superficial femoral artery is associated with an increased risk of thrombosis and limb loss.
- Unrecognized proximal femoral or iliac artery transection preventing endovascular access on the side of the injury. This may occur with penetrating pelvic trauma or severe pelvic fracture—check bilateral femoral pulses and access the side with a stronger pulse if there is a difference. Do not hesitate to switch to the opposite groin or convert to thoracotomy.

- Failure to address chest pathology. Always evaluate the chest by X-ray, ultrasound, or bilateral chest tube placement to identify and treat significant hemothorax or pneumothorax. Convert to thoracotomy to address massive hemothorax.
- Catheter or guidewire does not pass freely. This could indicate injury to the vessel. Do not inflate balloon. Consider accessing the opposite groin or convert to thoracotomy.
- Over-inflating the balloon. The ER REBOA balloon capacity is 24 ml. Zone 1 may require as little as 8 ml and Zone 3 as little as 2 ml to achieve occlusion. Over-inflation may rupture the balloon or injure the aorta.
- Leaving the balloon inflated too long. Only 30 minutes of Zone 1 occlusion is advised, and the shorter the better. Achieve rapid control of bleeding sites with temporizing measures such as clamping to allow the earliest reperfusion; most suturing, ligating, solid organ removal, and vascular shunting may be done after balloon deflation. Death secondary to ischemic injury has been reported with longer occlusion times.
- Failure to work with a heightened level of urgency once REBOA is placed. Some patients may regain "stability," however balloon occlusion is just like a cross clamp, with the same complications of visceral and spinal ischemia. Every effort should be made to restore perfusion as soon as possible to limit ischemia.
- Failure to adequately secure the REBOA catheter after balloon inflation, resulting in migration of the balloon. The catheter position must be maintained during and after inflation to avoid distal migration until aortic pressure and pulsatility are restored.
- Deflating the balloon too quickly before adequate volume resuscitation. Ensure that the anesthesia team is prepared for reperfusion prior to balloon deflation.
- Premature removal of the arterial sheath. The sheath should remain in place if the patient is coagulopathic, may have ongoing bleeding in the abdomen or pelvis, or is being transported within theater to a higher level of care.
- Injury to the arterial access point. After removal of the sheath, monitor the instrumented leg closely for re-bleeding and thrombus/intimal injury. Decreased lower extremity perfusion may require further angiography, thrombectomy, or direct arterial repair.
- Committing multiple resources to a futile resuscitation. Anticipate massive transfusion, personnel required, surgical supplies, diversion of resources from more salvageable casualties, etc.

FUTURE CONSIDERATIONS

A retrospective capability gap analysis of the UK Joint Theatre Trauma Registry suggested that as many as one in five severely injured casualties have wounds that may be amenable to treatment with REBOA.[61] The development of the 7 Fr ER REBOA catheter facilitates insertion of the device and may lead to more widespread use of this approach in the austere environment. Training non-physician caregivers to place REBOAs in the prehospital settings is being investigated.[62-63] Partial REBOA, intermittent REBOA, regional hypothermia, and pharmacologic adjuncts continue to undergo validation as a means of prolonging aortic occlusion time.[60,39,64] Ongoing research seeks to identify modifications to the REBOA technique that may be required when it is combined with other resuscitation modalities such as tranexamic acid. Researchers are also striving to clarify patient selection, evaluating the impact of REBOA on thoracic injury, and traumatic brain injury.[65] All of these advances should refine the

optimal use of this resuscitation adjunct. Longitudinal data in the civilian and military setting will assist in defining the ideal clinical situation in which REBOA can be of maximal benefit.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- Patients with AIS chest, abdomen, pelvis, and/or lower limb ≥3 with SBP >0 and <90 or CPR in progress on arrival to first MTF AND not isolated head injury (AIS head/face/neck = 5 or 6).
- Patients who received REBOA.

INTENT (EXPECTED OUTCOMES)

1. REBOA is not performed in patients with no signs of life or CPR >15 minutes or isolated severe TBI, penetrating neck injury, or penetrating extremity injury.
2. If performed, REBOA was performed for the indication of hemorrhagic shock associated with abdominal, pelvic, or junctional lower extremity bleeding, or other indication is clearly documented.
3. If REBOA performed, the patient was assessed for thoracic hemorrhage (EFAST or CXR results documented or bilateral chest tubes placed).
4. Blood pressure pre and post REBOA and balloon times (inflation and deflation) are documented in REBOA procedure note.
5. Lower extremity pulses are documented after balloon deflation.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients who had REBOA performed for hemorrhagic shock associated with abdominal, pelvic, or junctional lower extremity bleeding.
2. Number and percentage of patients who had REBOA performed who were assessed for thoracic hemorrhage (EFAST or CXR results documented or bilateral chest tubes placed).
3. Number and percentage of patients who had REBOA performed with complete REBOA procedure note to include documented blood pressure pre and post REBOA and documented balloon times (inflation and deflation).
4. Number and percentage of patients who had REBOA performed with lower extremity pulses documented after balloon deflation.
5. Number and percentage of patients who had REBOA performed with surgical hemorrhage control procedure or documentation that procedure not needed.
6. Number and percentage of patients who underwent ERT or REBOA in the population of interest.
7. Number and percentage of patients who did not undergo ERT or REBOA in the population of interest.

8. Number and percentage of patients who underwent ERT or REBOA who survived 24 hrs, 7 days, 30 days (assume alive if discharged alive prior to each time point).

9. Number and percentage of patients who did not undergo ERT or REBOA in the population of interest who were declared KIA/DOA or who survived 24 hrs, 7 days, 30 days (assume alive if discharged alive prior to each time point).

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

PI DATA CAPTURE AND REPORTING

- Number of REBOA interventions, performance, and adherence measures will be reported quarterly by JTS PI Branch Chief to the JTS Chief.
- JTS will identify REBOA patients in the trauma registry and facilitate capture of complete medical records.

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief, and the JTS PI Branch.

RESPONSIBILITIES

It is the responsibility of the JTS PI Branch Chief to ensure system-level compliance with this CPG. It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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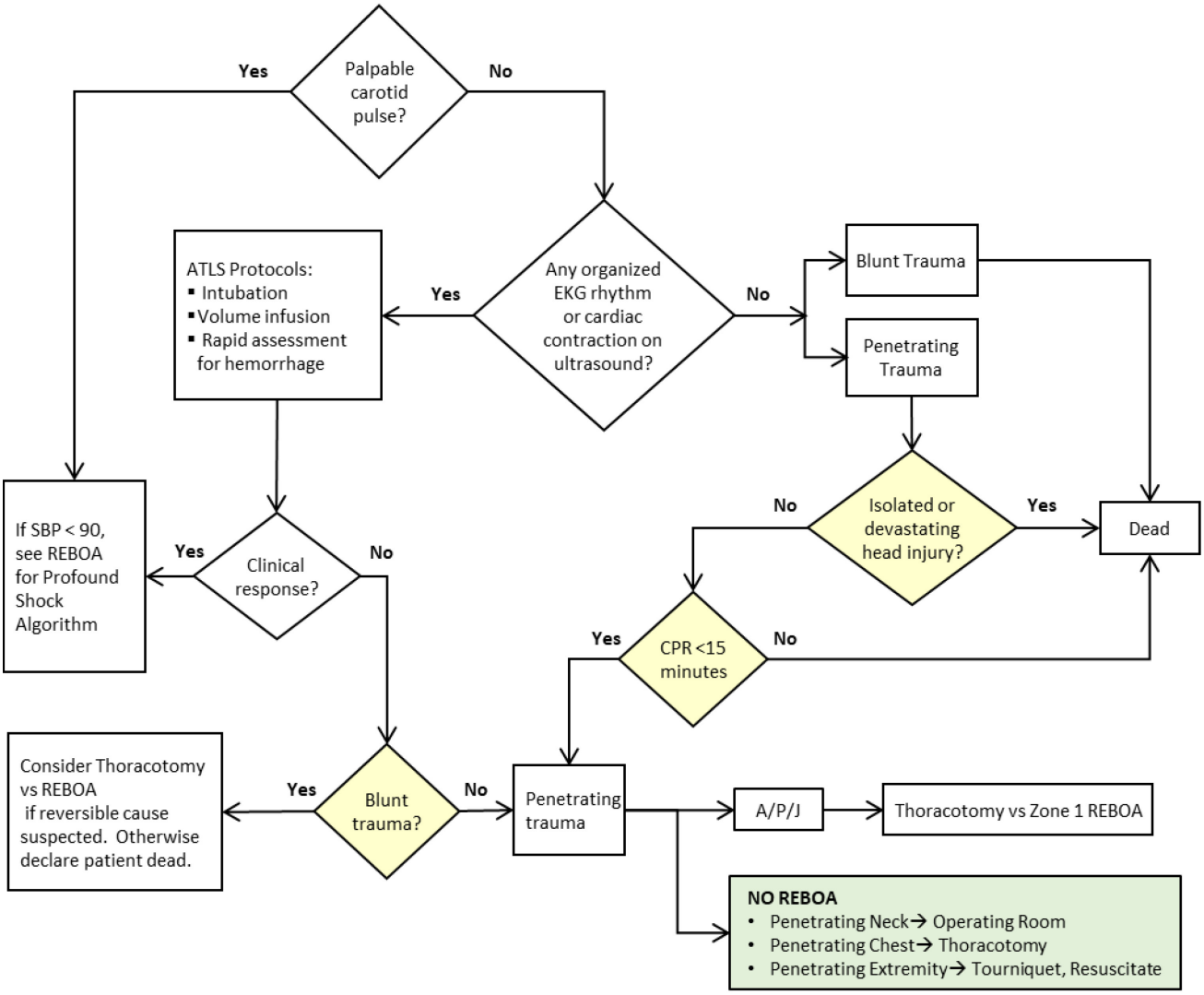
APPENDIX A: TRAUMATIC ARREST ALGORITHM

Traumatic Arrest Algorithm for Resuscitative Aortic Exclusion

- Blunt trauma with no major chest bleeding seen on CXR, ultrasound, or bilateral chest tubes
- Penetrating trauma to abdomen/pelvis



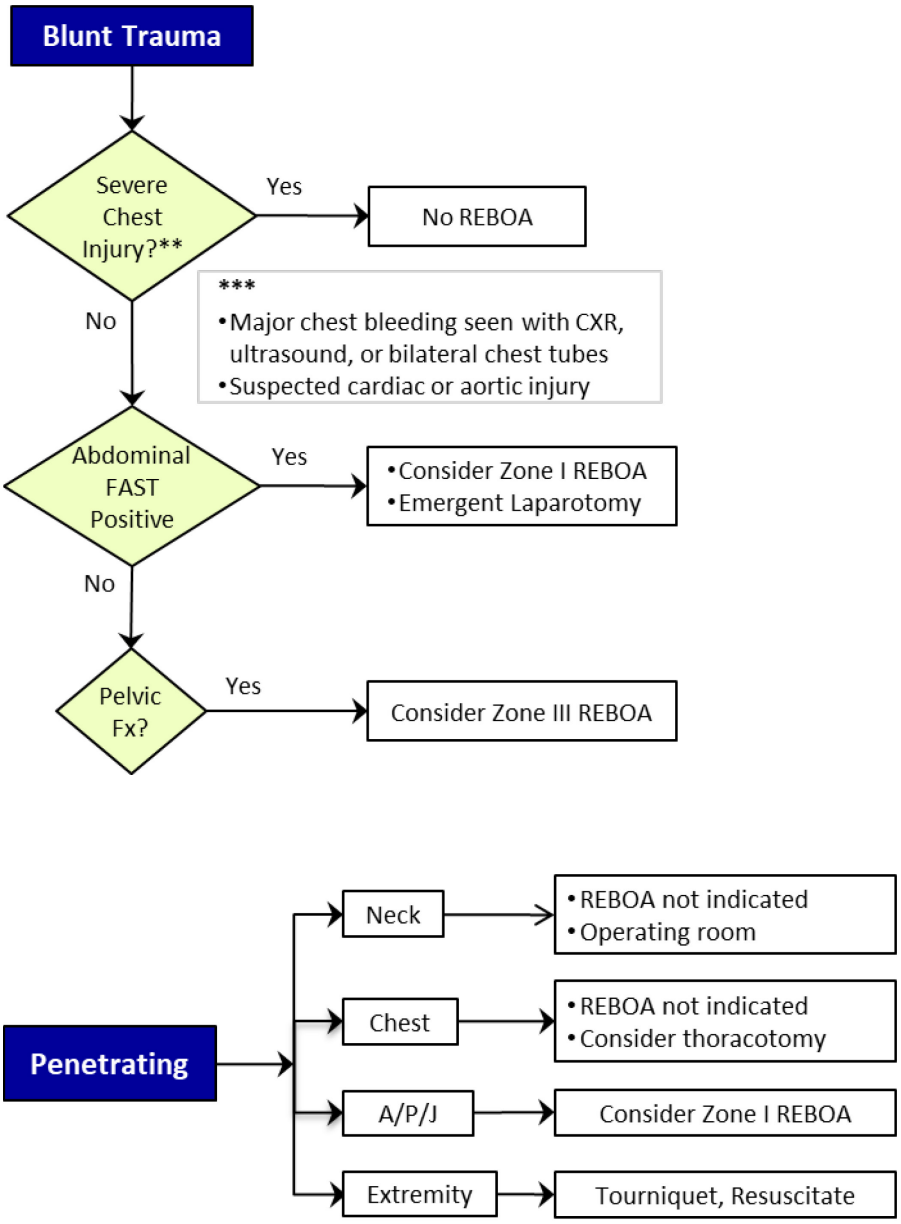
REBOA: Resuscitative Endovascular Balloon Occlusion of the Aorta; CXR: Chest X-Ray; EFAST: Extended Focused Assessment with Sonography for Trauma; ATLS: Advanced Trauma Life Support; EKG: Electrocardiogram; SBP: Systolic Blood Pressure; CPR: Cardiopulmonary Resuscitation; A/P/J: Abdomen/Pelvis/ Junctional Lower Extremity.

Zone I REBOA: placement of aortic balloon in the thoracic aorta (insert catheter to 46 cm, or measure the balloon to mid sternum, or /P-tip to the sternal notch)

Zone III REBOA: placement of aortic balloon directly above the aortic bifurcation (insert catheter to 27 cm or measure the balloon to the umbilicus or P-tip to the xyphoid process).

APPENDIX B: ALGORITHM FOR USE OF REBOA FOR PROFOUND SHOCK

SBP<90 with Transient or No Response to initial ATLS Resuscitation



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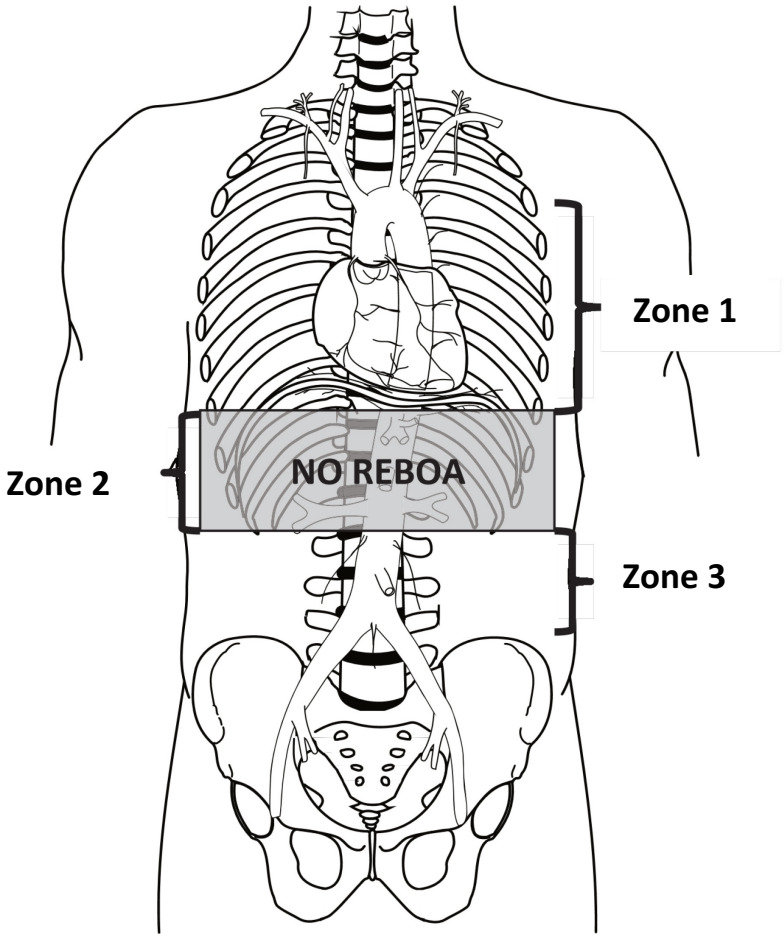
APPENDIX C: AORTIC ZONES



APPENDIX D: EQUIPMENT AND SUPPLIES FOR REBOA

- Ultrasound (linear probe for vascular access)
- Surgical set for open femoral artery exposure, including self-retaining retractors
- Scalpel (#11 or #15)
- 5 Fr micropuncture set or 18 Ga arterial line set (e.g., Cook Medical G43870, NSN 6515016591707; or Vascular Solutions, Inc 7208V; or Arrow Femoral Arterial Line UM-04018)
- 7 Fr arterial sheath (e.g., ER REBOA Catheter Introducer kit, Prytime Medical KT1835C; or Cordis Avanti 402-607x, NSN 6515016594864)
- ER REBOA catheter (Prytime Medical, NSN 6515016580745)
- Central line securing device
- Suture and Silk ties
- 3-way stopcock
- 30 ml Luer lock syringe
- 10 ml pre filled saline syringe x3
- Injectable saline (100 mL)
- Optional: Intravenous contrast (mix 8 mL in 16 mL injectable saline for balloon)
- Standard A-line setup; or Compass Device
- If able to be sterile: Ultrasound probe cover, Full body drapes, Sterile Scrub

APPENDIX E: REBOA STEPS USING 7 FRENCH ER-REBOA

The procedure may reviewed online using the following links:

Part 1: https://www.youtube.com/watch?v=-U7MkU3eA7E

Part 2: https://www.youtube.com/watch?v=DZ5LCEt7PBk

STEP 1: Arterial Access and Positioning of the Sheath

Establishing Arterial Access:

Access to the arterial circulation for REBOA for trauma should be obtained through the common femoral artery using one of three techniques: percutaneous, open exposure (e.g., cut down), or exchange over a guide wire from an existing common femoral arterial line.

Ultrasound is used to identify the common femoral artery above the branch of the profunda and the needle visualized passing into the common femoral artery (linear array transducer preferred). Ultrasound guided access improves first pass access and decreases complications.[1] Once identified, the artery should be entered at a 45-degree angle with the needle, using either a 5 Fr micropuncture kit or 18 gauge femoral arterial line kit. After the wire has been passed into the artery, the needle is removed and a small incision made at the interface of the wire and skin and the catheter is passed over the wire.

Using landmarks, the location of the inguinal ligament is identified between the Anterior Superior Iliac Spine (ASIS) and pubic symphysis (NOT the inguinal crease). The common femoral artery is then accessed 2 cm below the inguinal ligament.

Selection and Positioning of Initial Sheath:

If REBOA is indicated, the arterial access catheter must be upsized to a 7 Fr sheath. This maneuver is accomplished by placing a 0.035 guide wire greater than twice the length of the existing arterial catheter through its inner lumen allowing the catheter to be removed over the wire while maintaining arterial access. After a larger opening is created at the wire/skin interface, the 7 Fr working sheath with its internal dilator in position can be inserted over the wire. When urgently needed, a 7 Fr sheath may be placed as the initial step by placing the 7F sheath over the 0.035 guide wire though this can increase risk of access site damage.

The sheath's internal dilator must be firmly held in place to allow a smooth reverse taper from the wire to the diameter of the sheath to avoid arterial intimal injury. Once the dilator and sheath have been advanced over the wire through the skin into the artery, the dilator and wire are removed, leaving the sheath in place. It is important that the operator assure that the stopcock is in the "off" position to reduce bleeding.

STEP 2: Selection and Positioning of the Balloon

Selection of a Balloon:

The ER REBOA (Prytime Medical, New Braunfels, TX) is the only REBOA device covered by this CPG, as that it is the product chosen for use by the DoD. This is wire-free and fluoroscopy free and smaller caliber than previously used balloons, allowing fewer steps for insertion and a smaller introducer sheath (7 Fr). It also has arterial pressure monitoring capability.

Balloon Preparation:

Attach 30cc syringe to the ER-REBOA balloon port. The syringe will be filled with 24cc of 1/3 contrast 2/3 saline, or all saline if contrast not available. Negative pressure should be applied to the balloon to remove any air, then locked in place with the plunger at the 30cc mark on the syringe.

The a-line should be flushed with saline. The balloon will now pass easily into the peel-away sheath.

If using the pressure monitoring capabilities, the pressure sensor and tubing should be attached to the catheter's arterial stopcock and flushed with saline using standard arterial line setup and transducer connected to a monitor. Once the catheter is inserted, continuous care must be taken to prevent inadvertent emboli (air, thrombus, etc…) as well as keeping the a-line patent.

Balloon Positioning:

For Zone I occlusion, the catheter should be inserted 46 cm (or measured with the balloon from the midsternum, or the P-tip from the sternal notch to the femoral access catheter). For Zone III occlusion, the catheter should be inserted 28 cm (or the balloon measured at the umbilicus or the P-tip measured from the xiphoid process to the femoral access catheter). Distances are noted on the catheter shaft.

The peel away sheath is advanced over the P-tip and balloon to protect these as they enter the 7F sheath. The peel away sheath is advanced into the end of the 7F sheath approximately 5mm or until it hits a "stop." The REBOA catheter is then advanced 10cm into the sheath. The peel away sheath can then be slid back onto the catheter hub or removed, if full advancement is necessary. The catheter should be advanced to the predetermined depth. Plain film x-ray, ultrasound, or fluoroscopy can confirm correct positioning of the catheter and adjustments can be made if necessary, prior to inflation. There are two radio-opaque markers on the catheter to designate the location of the balloon. In cases of arrest there is no role for position confirmation and this can be done at a later time when the patient is stable.

STEP 3: Inflation of the Balloon, Securing of the Apparatus, and Monitoring

Inflation of the Balloon:

A 30 ml syringe should be used. Fill syringe to 24cc with 1/3 iodinated contrast and 2/3 saline, or all saline if contrast not available.[2] Balloon should be inflated until the blood pressure is augmented and contralateral femoral pulse is stopped, approximately 8 ml for Zone I or 2 ml for Zone III.

Do not over-inflate the balloon—balloon capacity is 24 ml—over-inflation can rupture the balloon or damage the aorta. Balloon inflation can be guided by fluoroscopy, hemodynamic response, and/or loss of the contralateral pulse. When fluoroscopy is available, inflate the balloon until the outer edges of the balloon change from convex to parallel as the balloon takes on the contour of the aortic wall. When inflation appears adequate to gain aortic wall apposition and/or central blood pressure is augmented, the three-way stopcock on the shaft of the balloon should be locked to maintain inflation and occlusion while other maneuvers are undertaken. Confirmatory X-ray may be used for radiographic confirmation of location. If no imaging is available in the austere environment, definitive confirmation of the balloon positioning should be accomplished directly with "hands-on" at the time of

laparotomy. If the balloon is found to be malpositioned (e.g., Zone 2) the balloon can be deflated and catheter positioned to Zone I or III and the balloon re-inflated.

Securing the Inflated Balloon and Sheath:

As the central aortic pressure improves, there is a risk of the catheter moving caudally. To prevent catheter migration, HOLD the catheter in place or secure the catheter to the sheath, and sheath to the patient with a central line attachment device. For added monitoring and security, assign an assistant the task of holding the apparatus until balloon deflation is desired.

Managing the patient pre-op:

A trained assistant should monitor and communicate the "big three" factors imperative to maintenance of successful REBOA: mean arterial pressure (MAP), maintenance of catheter position, and maintenance of occlusion (balloon inflation).

MAP: Immediately upon balloon inflation, and successful arterial occlusion, the MAP increases. In order to prevent negative effects of increased circulating volume leading to hypertension, the clinician should consider partial aortic occlusion if the MAP exceeds 100. The arterial waveform should be monitored for changes including over-dampening (flattened waveform) or under-dampening (hyper-dynamic waveform). Measures should be taken to ensure that the transducer, pressure tubing, and lines are problem-free. The pressure monitoring system should include dedicated pressure tubing, fully primed and air-free, not of excessive length, and with minimal use of stopcocks. Be sure all connections are tight, but not over-tightened.

Catheter position: The clinician should frequently check the measured distance of the catheter at the sheath to ensure that the catheter is not migrating. Notify the physician if catheter migration has occurred.

Maintenance of occlusion: Distal pulses should be monitored frequently. If pulses are present, and partial-REBOA is not intended, then balloon occlusion is not achieved and must be corrected. Notify the physician to add 0.5mm saline to the balloon and recheck MAP and distal pulses for evidence of complete occlusion.

STEP 4: Operative/Procedural Control of Bleeding

Control of bleeding below the diaphragm must occur very quickly, with a goal to keep the total aortic occlusion time less than 30 minutes. It is therefore important to start with damage control maneuvers to control bleeding such as clamping of the splenic or renal hilum, Pringle maneuver, clamping of any injured blood vessel, packing, or obtaining proximal and distal control of an injured blood vessel. At times, definitive control of bleeding such as solid organ removal, ligation of clamped vessels, or vascular shunt placement, may be deferred until after the REBOA has been deflated.

In patients with pelvic fractures, interventional radiology embolization may be considered when available, after intra-abdominal hemorrhage has been ruled out or controlled and the REBOA has been positioned in Zone 3.

STEP 5: Deflation of the Balloon

The balloon should be deflated once hemorrhage control has been obtained. Communicating with the assistant securing the catheter and the anesthesia team is critical before deflating the balloon. When deflating the balloon turn the three-way stopcock and withdraw saline slowly as this step can be anticipated to result in significant hypotension and may result in cardiac collapse. Further resuscitation may be necessary while deflating the balloon. While one person focuses on slowly deflating the balloon, another should hold the catheter and sheath in the position to avoid unintentional migration should the need to rapidly re-inflate the balloon arise. After balloon deflation, the team should anticipate hemodynamic changes related to reperfusion, washout of metabolic byproducts, and acidosis. As such, intermittent balloon inflation and deflation may be necessary during ongoing resuscitation until hemodynamic stability is restored.

STEP 6: Removal of the Balloon and Sheath

After REBOA is no longer required, the balloon may be deflated. It is imperative to have close communication with the anesthesia team to anticipate transient hypotension when the balloon is deflated. Once definitive hemorrhage control has been obtained, the REBOA sheath should be removed and 30 minutes of direct pressure applied to the CFA access site.

An angiogram through the sheath to document distal limb perfusion is best practice, though not always available. An aortogram may be best accomplished in the Role 3 environment with access to specialists and/or surgical backup.

The sheath should not be removed immediately prior to transport and is best removed where vascular complications can be treated and managed. If the anticipated patient transport time is less than 4 hours, the sheath may remain in place in patients with a high risk of rebleeding/continued bleeding. If patient transport time exceeds 4 hours the sheath should be removed at least 30 minutes prior to transport to allow for sufficient hemostasis at the CFA puncture site. These patients should be monitored closely en route for signs of access site complications. While the sheath is in place and up to 24hrs after removal, the patient should undergo bilateral lower extremity neurovascular checks every 1 hour. Providers should have a low threshold to involve vascular surgery or obtain a lower extremity arteriogram is any abnormalities arise.

Again, the sheath must NEVER be left in place for transfer to a host nation hospital.

Open vascular repair may be needed if a large sheath size is used, the patient is coagulopathic, or there is technical difficulty in sheath removal. If open surgical repair of the arterial access site is necessary, the femoral artery proximal and distal to the sheath entry site should be exposed to allow control. Proximally, this may require dissection for 2 cm to 3 cm underneath the inguinal ligament as an assistant uses a narrow handheld retractor (e.g., short Wylie renal vein retractor) to lift the inguinal ligament off of the femoral sheath. Exposure distal to the sheath entry site often requires identification and control of both the superficial and profunda femoris arteries. Once proximal and distal exposure and control with vessel loops or vascular clamps have been accomplished, the sheath may be removed. Consideration should be made for passage of embolectomy catheters distally to remove any potential clot and assure back bleeding. The resulting arteriotomy, especially the intima, should be closely examined and tailored with Potts scissors if necessary to allow primary transverse closure. Closure of the arteriotomy should be performed transversely using 5-0 or 6-0 permanent monofilament suture in either an interrupted or running fashion with care to capture all layers of the arterial wall with passage of the needle. Before closing the last suture, forward bleeding and back bleeding of the arterial segments should be allowed followed by flushing of the surface with heparinized saline. Restoration of flow through the arterial segment should be confirmed using manual palpation for pulses distally and use of continuous wave Doppler of both the artery and more distal extremity. If there is any question of flow, it is recommended to perform an angiogram and appropriate intervention if any abnormalities are noted. Closure of the soft tissues above the femoral artery is accomplished in layers using absorbable suture in the soft tissues.

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APPENDIX F: ER-REBOA PROCEDURE CHECKLIST

1. Resuscitate per advanced trauma life support.
2. Rule out major thoracic trauma (CXR/EFAST/Bilateral chest tubes)
3. Confirm abdominopelvic source of shock (FAST exam and Pelvic X-ray if blunt trauma)
4. Confirm bilateral femoral pulses are present
5. Establish arterial access with 7 Fr Sheath in an uninjured common femoral artery
6. Measure balloon distance
7. Evacuate the balloon
8. Flush the arterial line
9. Insert the catheter
10. Inflate the balloon (Zone 1: start with 8ml; Zone 3: start with 2ml)
11. Secure the catheter
12. Control major bleeding
13. Monitor the patient, hemodynamics, catheter, and sheath
14. Resuscitate and deflate the balloon
15. Complete damage control surgery
16. Remove sheath when coagulopathy corrected
17. Check distal pulses after sheath removal

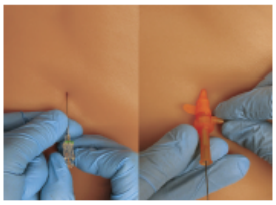
APPENDIX G: ER REBOA QUICK REFERENCE GUIDE

Disclaimer: The JTS does not endorse a specific catheter or products for REBOA. The purpose of this reference guide is to educate providers on the proper use of the catheter to improve clinical care.

The ER-REBOA™ Catheter Quick Reference Guide

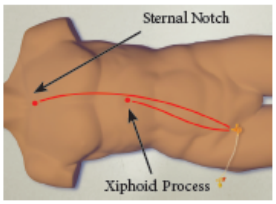
6 REBOA Steps: ME-FIIS (Pronounced 'Me-Fiz')

Get Early CFA Access



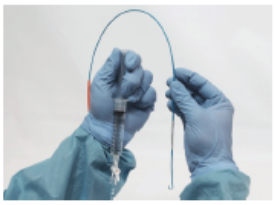
Obtain access using standard techniques

1. Measure

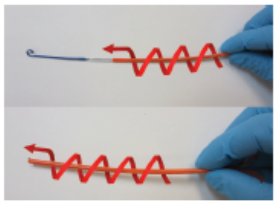


Placement depth[1,2,3,4,5,6]
- Zone 1: ~ 46 cm
- Zone 3 : ~ 28 cm

2. Empty



Deflate balloon
- Ensure balloon is fully deflated
- Hold vacuum for **5 seconds** and close stopcock

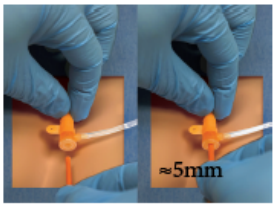


Advance & twist peel-away to cover P-tip®
- Corkscrew twist to wrap balloon tightly
- Ensure the balloon and P-tip® are captured

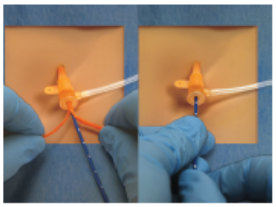
3. Flush

Attach & flush arterial line
- Use standard techniques
- Ensure all air is purged

4. Insert



Insert peel-away into valve
- Approximately 5 mm



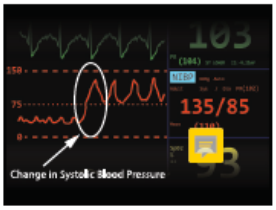
Advance catheter to desired depth
- Hold orange peel-away
- Advance blue Catheter
- Pull peel-away back after balloon passes valve

Position catheter
If available, use x-ray or fluoroscopy to confirm position using radiopaque markers

5. Inflate[1,2,3,4,5,6]

Inflation Volume	
Zone 1	Start with 8 cc
Zone 3	Start with 2 cc

"Start 2, Start 8, Don't Overinflate."
Start small, then check



Monitor arterial waveform feedback
- Look for increase in blood pressure above balloon
- Feel for loss of contralateral pulse
- **Mark time of inflation**

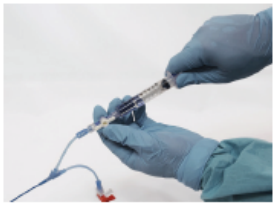
6. Secure

Secure Catheter close to the introducer sheath

Provide Definitive Treatment

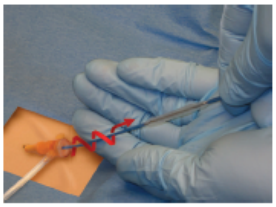
Provide definitive hemorrhage control
- The clock is ticking!
- Move quickly to definitive control

Deflate



Deflate slowly
- Prepare team for potential rebound hypotension

Remove



Fully deflate balloon
- Hold vacuum for **5 seconds** and close stopcock
- Corkscrew twist the catheter to facilitate removal
- If necessary, remove catheter and introducer sheath as a unit

Caution

Check for full and equal pulse in each leg using your standard technique

PRYTIME MEDICAL™
The REBOA Company™
www.prytimemedical.com

This instruction is not a replacement for the instruction for use (IFU). The ER-REBOA™ Catheter IFU should be read in its entirety before using the device

1. Joint Trauma System Clinical Practice Guideline [JTS CPG] REBOA for Hemorrhagic Shock (CPG ID: 38)
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ADV-006 | Revision H

APPENDIX H: AORTIC OCCLUSION PROCEDURE NOTES

Aortic Occlusion (AO) Procedure Notes: REBOA or Resuscitative Thoracotomy

Complete all items that apply. Include in Patient's Medical Record. Upload into TMDS. Leave blank unknown or unavailable items. Note time in hh:mm format.

Patient Last Name | First Name | Last 4 SS# | Age | Gender ◯ M ◯ F | Date/time of Injury

Date/time of arrival to AO MTF | 1st MTF from POI? ◯ Yes ◯ No | Type of MTF ☐ Austere surgical team ☐ Role 2 FRST/FST ☐ Role 3

Type of Injury (select all that apply) ☐ Penetrating ☐ Blunt ☐ Burn ☐ Other (specify)

Body region (select all that apply) ☐ Right chest ☐ Left chest ☐ Head ☐ Neck ☐ Mediastinum ☐ Abdomen ☐ Pelvis ☐ Upper limb(s) ☐ Lower limb(s)

Mechanism of Injury (select all that apply) ☐ GSW ☐ Blast ☐ Mounted IED ☐ Dismounted IED ☐ Vehicle crash ☐ Other (specify)

POI Vitals 1st SBP | 1st HR | 1st GCS | Prehospital CPR required Yes ◯ No ◯

Assessment SBP | HR | GCS | Temp | Distal pulse palpation prior to insertion Yes ◯ No ◯

Presence of signs of life (select all that apply) ☐ Palpable pulse ☐ Organized cardiac activity on monitor ☐ Organized cardiac activity on ultrasound

CPR in progress upon arrival Yes ☐ No ☐ | Total duration of CPR (prehospital & hospital, in minutes)

(E) FAST ultrasound results ☐ Negative (select sites that were positive) **CXR results** ☐ Negative (select all positive CXR results that apply)

☐ Pericardium ☐ Right chest ☐ Left chest ☐ RUQ ☐ LUQ ☐ Pelvis ☐ Pneumothorax ☐ R ☐ L ☐ Hemothorax ☐ R ☐ L ☐ Mediastinal Injury

Chest tube output ☐ Right | cc ☐ Left | cc ☐ Chest tube not placed

Initial labs Hgb (mg/dL) | INR | pH | Base deficit +/- | Lactate (mg/dL)

AO Initiation ☐ Open ☐ REBOA | Was active CPR ongoing during initial AO attempt? Yes ☐ No ☐ | Date/time of AO initiation

Why was this type of AO selected? (select all that apply) ☐ Provider preference ☐ REBOA contraindicated ☐ Thoracotomy not indicated ☐ REBOA supplies not available ☐ Not trained in REBOA

REBOA technical features

Initial catheter diameter size:

18 Ga ☐ 4 Fr ☐ 5 Fr ☐ 7 Fr ☐

Volume required to inflate balloon | cc

Was successful AO achieved? Yes ☐ No ☐

Was hemodynamics improved with AO? Yes ☐ No ☐

Inflation technique ☐ Full ☐ Partial ☐ Intermittent

Immediate post inflation vital signs

SBP | HR | GCS

Insertion site: Right ☐ Left ☐ ☐ Common Femoral ☐ Other

Was initial catheter upsized? Yes ☐ final size= | No ☐

Where was balloon deployed?

☐ Zone I (Origin of left subclavian artery to the celiac artery)

☐ Zone III (Lowest renal artery to the aortic bifurcation)

Duration of AO (by balloon inflation or clamp time, in minutes):

Deflation technique ☐ Full ☐ Gradual

Date/time of REBOA sheath removal | Total inflation time

Complications (select all that apply)

☐ Death ☐ Extremity ischemia ☐ Amputation secondary to REBOA use ☐ Pulmonary embolism ☐ DVT

☐ Renal failure ☐ Infection ☐ Hematoma ☐ Stenosis ☐ Arteriovenous fistula

☐ Need for arterial bypass ☐ Pseudoaneurysm ☐ Dissection at insertion site ☐ Need for patch angioplasty

☐ Vessel injuries (aortic dissection, rupture, perforation) ☐ AO technique issue | ☐ Device malfunctions | ☐ Other complications

Comments

Provider Name | Provider Specialty

Additional AAR comments, suggestions, lessons learned can be emailed to: dha.jbsa.healthcare-ops.list.jts-pips@health.mil

03 Feb 2021, version 2.1

APPENDIX I: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Sepsis Management in Prolonged Field Care

This CPG focuses on the most common etiologies of sepsis, and the treatments of those forms of sepsis that the austere provider can reasonably manage.

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INTRODUCTION

This Role 1 prolonged field care (PFC) guideline is intended for use in the austere environment when evacuation to higher level of care is not immediately possible. A provider must first be an expert in Tactical Combat Casualty Care (TCCC). The intent of this guideline is to provide a functional, evidence-based and experience-based solution to those individuals who must manage patients suspected of having or diagnosed with sepsis in an austere environment. Emphasis is placed on the basics of diagnosis and treatment using the tools most familiar to a Role 1 provider. Ideal hospital techniques are adapted to meet the limitations of austere environments while still maintaining the highest standards of care possible.

Sepsis and septic shock are medical emergencies. Patients suspected of having either of these conditions should be immediately evacuated out of the austere environment to higher echelons of care. These patients are often complex, requiring 24-hour monitoring, critical care skills, and a great deal of resources to treat. Obtaining evacuation is the highest treatment priority for these patients. This Clinical Practice Guideline (CPG) utilizes the minimum, better, best paradigm familiar to PFC, and gives medics of varying capabilities and resources options for treatment.

SEPSIS DEFINITIONS

Sepsis: Life-threatening organ dysfunction caused by a dysregulated host response to infection (Sepsis-3 definition, adopted by Surviving Sepsis Campaign in 2017).[1]

Septic Shock: Persistent hypotension requiring vasopressors to maintain mean arterial pressure (MAP) > 65 mmHg and having a serum lactate > 2 mmol/L despite adequate volume resuscitation.

Shock is one of the most common complications of severe injury or illness. Shock is separated into four different classes: 1) hypovolemic (including hemorrhagic), 2) cardiogenic, 3) obstructive, and 4) distributive. Septic shock is a form of distributive shock. The hallmark of managing shock is:

1. early recognition (including an awareness that the magnitude of injury or illness has the potential to lead to shock);
2. identification of the cause of shock; and
3. early, decisive treatment of the cause and initiation of cause-specific resuscitation.

Severe infection is often a greater risk than trauma in the PFC environment. Trauma-associated sepsis is an important subset of sepsis in the military population, with a potential for casualties to develop severe wound, respiratory, urinary, and bloodstream infections related to their initial injury and initial treatment procedures (IV/IO catheters, foley catheters, etc.). Up to 38% of trauma-related sepsis is bloodstream-related.[2] In the trauma patient, the manifestation of sepsis is often several days after initial presentation which makes sepsis particularly relevant in the PFC environment over a Role 1 with greater medevac capability.[3] Early antibiotic therapy and hemodynamic resuscitation with fluids and vasopressors are the key initial therapies for the septic patient. Source control is similarly critical and may require surgery. When this is not possible in the PFC environment, the patient must be supported and transported to a location with surgical capability as rapidly as possible.

SEPSIS MANAGEMENT GOALS

Sepsis management goals should include the following:[1]

- Early suspicion and recognition.
- Source identification.
- Early antimicrobial therapy.
- Resuscitation.
- Source control.
- Patient monitoring through trending patient information.
- Early telemedicine consultation.
- Evacuate to definitive care.

EARLY SUSPICION AND RECOGNITION

***GOALS**: Recognize sepsis and review the differential diagnosis; identify systemic infection before it progresses to decompensated shock; and identify patients who require evacuation.*

Infection may take many forms in initial presentation. Common examples include viral upper respiratory infections, gastroenteritis, urinary tract infections, cellulitis, and pneumonia. In addition, infections associated with travel, to include diarrhea, vector-borne diseases (malaria, dengue fever, etc.) and some respiratory pathogens will be particularly common in certain areas of the world. A comprehensive history of illness, to include travel history, should be obtained initially. Many infections may be managed adequately without evacuation or need for higher levels of medical care.

Differential diagnoses of presentations attributed to infections must be considered as well. Sepsis "mimics" anaphylaxis, gastrointestinal emergency, pulmonary disease including pulmonary embolism, metabolic abnormality including hyperthyroidism and adrenal insufficiency, toxin ingestion, toxin withdrawal, vasculitis, and spinal injury.[4] If the condition progresses to septic shock, "mimics" may include other causes of shock such as myocardial infarction, gastrointestinal bleeding, dehydration, heat injury, and hypovolemia secondary to gastrointestinal losses. If infection and sepsis are still prominent in the differential diagnosis after considering these other causes of shock, a focused assessment should be pursued, as detailed below. Any patient showing evidence of sepsis or septic shock should immediately be classified as an urgent evacuation priority.

HISTORY AND PHYSICAL EXAM

Minimum: "**SAMPLER**" history (**S**ymptoms/subjective complaints: **A**llergies to medications; **M**edications taken or prescribed; **P**ast medical and surgical history; **L**ast meal/oral intake; **E**vents leading up to presentation; and **R**ecent travel). Initial vital signs on presentation. Trending of vital signs (e.g., on PFC flow sheet found on the JTS Forms website) when looking for signs of severe infection are: fever or hypothermia; increase in heart rate; increase in respiratory rate; and, generally later rather than earlier, a decrease in blood pressure. Additionally, monitor mental status, SpO2, and capillary refill. Complete secondary survey physical exam. Look for Systemic Inflammatory Response Syndrome (SIRS), quick

Sepsis-related Organ Failure Assessment (qSOFA) criteria[5] and/or a high NEWS2 score[6], listed below. Look for potential sources of infection. Establish blood type of patient using an Eldon card.

- **Better**: Above, plus: Addition of simple labs: urine dipstick, BinaxNOW (malaria), i-STAT (or other point-of-care laboratory) values with vitals monitoring mentioned above. See i-STAT values in Appendix B. If available, monitor lactate.
- **Best**: Above, plus: Thick and thin smear (malaria), laboratory values (including lactate), culture data from likely source(s).

The more indicators of systemic infection, the higher the suspicion for the treating clinician. This is the "whole-patient" approach. A comprehensive problem list will be important to organize patient care. If sepsis is suspected, telemedicine should immediately be initiated (if possible) to help guide both diagnosis and therapy. Monitor vital signs constantly to guide treatments.

The Systemic Inflammatory Response Syndrome (SIRS) is a sign of an inflammatory reaction to a severe physiologic insult. Although no longer part of the definition of sepsis, SIRS is a useful tool in identifying patients at risk of acute decompensation. The SIRS criteria consist of four indicators:

1. tachycardia (heart rate >90 beats/minute)
2. tachypnea (respiratory rate >20 breaths/minute or PaCO2 < 32 mmHg)
3. fever or hypothermia (temperature >38°C/100.4°F or <36°C/96.8°F)
4. leukocytosis or leukopenia (white blood cell count >12,000/mm³, <4,000/mm³, or > 10% bands).[7]

A practitioner in an austere environment may not be able to measure all these indicators (especially WBC), but an understanding of these features of early sepsis may prompt earlier identification of disease and direct more-timely therapeutic interventions.

qSOFA is the more recent sepsis screening tool; it seeks to identify patients at an increased risk of death.[5] The presence of two or more of the following three qSOFA indicators should increase the clinician's index of suspicion for sepsis: 1) altered mental status, 2) tachypnea (>22 breaths per minute), and 3) hypotension (SBP <100mmHg).

WARNING

Hypotension is a late sign in sepsis. ***Do not wait for blood pressure to fall before initiating treatment and resuscitation*** *in a patient who is showing multiple signs of systemic infection (fever, tachycardia, tachypnea, altered mental status, decreased urine output). Delaying intervention until blood pressure falls can make it harder to get the systemic inflammatory reaction under control and increase risk of death.*

A more in-depth tool used in the prediction of ICU admission shown to be more effective than qSOFA is the NEWS2 score which is based on only clinical measurements and assessment. NEWS2 incorporates more variables, making it less "quick" than the qSOFA. Although not applied in clinical practice to sepsis evaluation exclusively, it may be a very useful tool in predicting clinical deterioration. The clinical variables required to compute a NEWS2 score include respiratory rate, hypercapnic respiratory failure (yes/no), oxygen saturation (and need for supplemental oxygen), temperature, heart rate, systolic blood pressure, and general level of consciousness. These parameters are recorded using a scale system, assigning points between 0-3 for each parameter. This tool has been shown to be superior to qSOFA for detecting sepsis with organ dysfunction in the emergency department.[8]

The following clinical assessment – history and physical exam findings – should raise the suspicion for early sepsis:

SUBJECTIVE ASSESSMENT

- Patients with sepsis may report the below complaints, with no other obvious non-infectious source (i.e. bleeding, traumatic brain injury, heat injury).
- Chills and rigors
- Confusion
- Malaise: feeling weak, with little or no energy

OBJECTIVE ASSESSMENT

Physical exam findings of patients with sepsis may include:

- Concerning (or obvious) sources of infection:
  - Wound(s) displaying signs of infection (i.e. pain, redness warmth, purulent drainage, swelling).
  - Indwelling catheters (IV/IO/urinary) or devices in less-than-sterile/field environment.
- Temperature of >38°C/100.4°F or < 36°C/96.8°F.
- Cool skin, cyanosis, delayed capillary refill time (>3 seconds).
- Abnormal vital signs, particularly tachycardia (> 90 bpm), sustained hypotension (systolic blood pressure <90 mmHg), tachypnea (>20/min).
- Low urine output (oliguria).
- Altered or worsening mental status (confusion, lethargy).
- Rash, purpura (meningococcemia, Rocky Mountain spotted fever, other rare etiologies).
- Meets the SIRS Criteria; qSOFA criteria and/or high NEWS2 score (see above).
- Lab specific values. (See Appendix B.)

***NOTE**: Typical symptoms may not be present in some patient populations. Signs of sepsis may be attenuated and/or muted in the elderly, delayed manifestation in the very young, or masked in pregnancy due to the normal physiologic changes and absence of a febrile response in up to 50% of pregnant patients.*

SOURCE IDENTIFICATION

***GOAL**: Locate probable cause of infection to most appropriately address the source.*

Approach to Source Identification:

- Gather a complete patient history of recent and/or ongoing illnesses.
- Conduct a thorough head-to-toe exam to look for evidence of infection – wounds, bites, etc. Be sure to examine the genitourinary and perirectal areas, as these are common sites of missed infections.
- Perform rapid malaria, dengue, and point of care source tests if in an endemic area, as well as urine dipstick and i-STAT labs.[9]

Sepsis may be of bacterial, fungal, viral, or parasitic origin. Bacterial infections are the most common causes of sepsis followed by parasitic (mainly malaria), viral (e.g., dengue, influenza, COVID-19), and finally, fungal diseases.[10] The prevalence of each is directly related to a given region.[11] Identifying the cause of sepsis is challenging in the PFC environment where advanced diagnostic tests are unavailable, and antiviral and antifungal therapies are rarely available. This CPG focuses on the most common etiologies of sepsis, and the treatments of those forms of sepsis that the austere provider can reasonably manage. Advanced preparation is important, and a medical area study and/or medical threat-model analysis should be done prior to traveling to gather data on microbes specific to that given region.

For a given region, bacterial sepsis is most often due to a limited number of common pathogens to include streptococci (including *S. pneumoniae*, which causes pneumonia and meningitis), Staphylococci, *Neisseria meningitidis* (also a cause of meningitis, particularly common in regions of sub-Saharan Africa), and gram-negative bacteria arising in the gut. Treatment of many of these infections is complicated by rising rates of antibiotic resistance worldwide.[12]

Malaria must be considered high on a differential diagnosis list as a leading cause of any febrile illness in an endemic region. In the typical patient from an industrialized country without prior exposure to the infection, malaria can be rapidly fatal in the absence of early and specific therapy.[13]

A significant minority of sepsis cases (up to 15%) are due to fungal infections. *Candida* species are normal flora in the human gut and vaginal canal and are the most common causes of fungal sepsis, followed by invasive mold infections such as *Aspergillus* and by endemic fungi causing community-acquired disease, including *Histoplasma*, *Coccidioides*, and *Talaromyces*. In the PFC environment, *Candida* infections may follow penetrating abdominal trauma with perforation of the gut, while invasive molds may arise after blast injuries with devitalized tissue (such as after a high lower extremity amputation). Therapeutic options for both of these scenarios are very limited in a PFC setting.

Because war wounds are considered grossly contaminated wounds, they must be attended to meticulously. Unattended wounds can lead to acute infection and sepsis within days (or possibly within hours for very large and contaminated wounds).[14] Quality wound care is essential to infection and sepsis prevention as detailed in the *JTS Acute Traumatic Wound Management in the Prolonged Field Care Setting CPG*.[15]

TREATMENT

ANTIMICROBIAL THERAPY

***GOAL**: Use targeted and most appropriate antibiotic therapy when possible.*

Antibiotic regimens: See the *JTS Acute Traumatic Wound Management in the Prolonged Field Care Setting CPG*.

- **Minimum**: Moxifloxacin 400 mg PO daily (or levofloxacin 750 mg PO daily to provide better coverage of bacteria found in wet terrain/jungle environment).
- **Better**: Ertapenem (Invanz) 1 gram IV/IO once per day (q24 hrs) given over 5 to 10 minutes or IM (not preferred), OR ceftriaxone (Rocephin) 2 grams IV/IO given over 10 minutes q24hrs.
- **Best**: Ceftriaxone (Rocephin) 2 gm IV/IO q24 hrs given over 30 minutes, PLUS vancomycin (Vancocin) 15 mg/kg IV/IO q12 hrs. (given after ceftriaxone, given over 2 hours) PLUS metronidazole (Flagyl) 500 mg IV/PO/IO q8hrs, given over one hour.

ANTIPARASITIC REGIMENS

If sepsis is suspected in a malaria-endemic area and there is no other clearly identified source, conduct a malaria point-of-care test BINAX Now® and thick and thin smears, if available. If positive, administer both antibiotics and antimalarials. If unable to test for malaria, empiric antimalarial therapy can also be considered. Additionally, in a malaria-endemic area, when a patient is initially unresponsive to antibiotic therapy, add antimalarials.

- **Minimum:** Atovaquone/progauanil (Malarone) 4x3 regimen – 4 tablets PO once a day for 3 days.
- **Best:** Artemether/lumafantrine (Coartem) 4 tablets PO initially, then 4 tablets after 8 hours, then 4 tablets PO twice daily for 2 more days (24 tablets total).
- **Severe Malaria:** The optimal treatment for severe malaria (defined as malaria with associated findings such as altered mental status, acidosis with lactate >5 mmol/L, prostration, hypoglycemia, parasitemia >10%, hemoglobin <7 g/dL, creatinine >3 mg/dL, pulmonary edema, shock, or pathologic bleeding), the drug of choice is IV artesunate 2.4 mg/kg IV/IO at 0, 12, 24, and 48 hours (4 doses), followed by 3 days of either Malarone (4 tablets PO, for 3 days) or Coartem (4 tablets initial dose, followed by 4 tablets given 8 hours later, followed by 4 tablets twice daily for the next 2 days; 24 total tablets).

- ***NOTE 1:** Although artesunate may be available in tropical countries, the quality of formulation may not be at FDA standards and telemedicine assistance and initiation of medevac should be initiated for severe malaria.*
- ***NOTE 2:** If unable to obtain artesunate, we recommend Coartem or Malarone with teleconsultation assistance and initiation of medevac.*

ANTIFUNGAL REGIMENS

Do NOT administer without telemedicine. When advised, antifungal drugs are administered in conjunction with the antibiotic regimen mentioned above.

- **Minimum**: Fluconazole 400 mg PO or IV daily (note that PO is equipotent to IV).
- **Better/Best**: Due to the complexity and toxicity of many anti-fungal medications, this CPG will not extend beyond the minimum recommendation.

RESUSCITATION

***GOAL**: Meet perfusion goals by replenishing intravascular volume and using adjunctive medications (i.e. vasopressors) as indicated.*

***CAVEAT: If you are treating sepsis in the setting of trauma, resuscitate with whole blood or blood component therapy as you would for trauma. (See *JTS Damage Control Resuscitation – PFC CPG*.[16])

FLUID RESUSCITATION CONSIDERATIONS

- **Minimum**: In the absence of IV/IO capability, have the patient drink water and monitor urine output with a goal of averaging 0.3-0.5 mL/kg/hr. Include an oral rehydration solution for those patients who cannot consume food but can drink water (use either proprietary mixtures or fabricated – 6 teaspoons of granulated sugar with ½ teaspoon of table salt in 1 liter of water. See the *JTS Nursing Intervention – PFC CPG*.).[17] Rectal fluids (begin at 100mL/hour and increase rate to a maximum of 500mL/hour) may be used for patients who cannot tolerate oral fluids. Use oral rehydration solution mentioned above for rectal administration.
- **Better**: IV/IO crystalloid bolus (up to 30mL/kg of IV crystalloid within the first 3 hours) until a urine output of 0.3-0.5 mL/kg/hr is reached. This output can be measured using any external measuring device – water bottles, graduated collecting bottle, etc.
- **Best**: The same fluid resuscitation strategy as above with the addition of a urinary catheter in place for more precise measuring of urine output (ensure the first catch from a recently placed catheter is discarded and not documented in total output calculations).

The first step in resuscitation of the sepsis/septic shock patient is the replenishing of intravascular volume ("fill the tank"), ideally with IV/IO administration of crystalloids. The preferred fluids for IV/IO resuscitation in order of preference are: Lactated Ringers (LR) (or Plasmalyte A), then normal saline. Chloride-restricted IVF (LR/Plasmalyte A) are ideal for larger boluses (>3-4L) or ongoing resuscitation.[18] When administering large amounts of IV/IO fluids, monitor for over-resuscitation and pulmonary edema, indicated by lung auscultation (rales or "wet lungs"), increased work of breathing/decreased oxygen saturations, and evidence of edema on a plain chest film or ultrasound (if available). Urine output, with a goal of 0.3-0.5mL/kg/hr, should indicate adequate fluid resuscitation in a patient with normal kidney function, however, some patients in septic shock may have acute kidney injury (AKI). As such, initial bolus of crystalloids should not exceed 2-3 liters maximum, and further fluid administration should be based on blood pressure and measures of perfusion (capillary refill), as well as measured losses (gastrointestinal, etc.). Higher urine output (> 0.5mL/kg/hr) indicates over-resuscitation. Additionally, if labs are available, resuscitation to a normalized lactate level would be further indication

of positive improvement. It is also important to monitor serum electrolytes as abnormalities of sodium and potassium levels are particularly common during fluid resuscitation.

Negative trends of sepsis-induced hypoperfusion may include low and/or steadily decreasing SBP and/or delayed capillary refill (>3 seconds), an important indicator for measuring perfusion. In response to negative shifts in the patient's hemodynamic status – a SBP that drops below 90 mmHg, and/or a Mean Arterial Pressure (MAP) that drops below 65 mmHg – initially increase the fluid resuscitation by 20 percent (watching for signs of over-resuscitation above).

***Key point**: Over-resuscitation carries considerable risk including acidosis, dilution of clotting factors, pulmonary edema, ascites, hypernatremia and peripheral edema. If the patient's blood pressure and organ dysfunction (e.g., urine output and mentation) is not responding to recommended maximum resuscitation of 30 mL/kg over the first 2-4 hours of initiating treatment, seek telemedicine guidance on whether to cautiously give more fluids or start vasopressors.*[19]

DRUG CONSIDERATIONS

Vasopressors: Consider, if, after initial fluid resuscitation (reaching initial urine output goals or maximum of 30mL/kg IVF bolus in the first 2-4 hours), there is no observed positive change in SBP, MAP, urine output and/or mentation (fluid-refractory shock). If vasopressors are used after initial fluid resuscitation, do not administer more fluids as this can likely cause dangerous fluid shifts; implement telemedicine. ***Consider starting low dose vasopressors ONLY under guidance of telemedicine consultation**, with norepinephrine (first choice) or epinephrine (alternate)*[20] See Appendix F.

SOURCE CONTROL

***GOAL**: Eliminate the source of infection.*

Some infection sources are treated only with antibiotics, while others may require surgery to remove or drain the infection source. A full patient exam should be performed to look for sources of infection that may not have been identified on the initial patient survey and serial exams should be performed as part of ongoing patient assessment to track physical signs of infection spread or response to therapy. With wound sepsis, quality wound care is critical to infection and sepsis treatment and prevention as previously detailed in the *JTS Acute Wound Management - PFC CPG.*

Any identified potential infection sources such as foreign bodies, old indwelling catheters (to include IV/IO, urinary, etc.) and dead or dying tissue must be evaluated and attended to immediately. All previously inserted urinary or other indwelling catheters and IV/IO catheters should be removed and replaced if possible. Those that are not needed to immediately care for the patient should be considered for removal. All wound dressings should be removed, and any sign of infection requires surgical wound exploration. All dead infected tissue must be removed, up to and including amputation when needed. Any abscesses or infected spaces must be completely drained. Any suspected intrathoracic or intraperitoneal infection sources must be attended to by a surgeon urgently. Always initiate antibiotics and fluid resuscitation prior to attempting surgical interventions.

Aggressive and adequate surgical source control is essential to the patient's survival. Obtain telemedicine consultation from a surgeon.

MONITOR THE PATIENT

Monitor the patient for trend available vital signs, urine output, capillary refill, and adjuncts (ultrasound and/or labs if available).

***GOAL**: Establish a baseline and measure response to interventions.*

- **Minimum**: Serial vital signs measurement, mental status assessment, and urine output. Vital signs trends and interventions recorded on flowsheet.
- **Better**: Add point-of-care lactate every 6 hours until normal.
- **Best**: Add ultrasound monitoring to assess and trend inferior vena cava (IVC) and left ventricular (LV) filling, decrease in "hyperdynamic" cardiac physiology.

Employing focused, goal-oriented interventions as early as possible has shown to decrease mortality. The following goals will direct treatment initiatives. Medical providers should develop and prioritize a problem list with an accompanying treatment-solutions plan to meet the below therapy goals.

- **Systolic blood pressure (SBP) > 90 mmHg and/or palpable radial pulse** (if blood pressure monitoring is not available). SBP is the most appropriate and feasible modality for monitoring a patient's perfusion status.
- **Mean Arterial Pressure (MAP) > 65**. MAP is manually calculated using the formula (Systolic BP + (2 x Diastolic BP))/3. Most electronic monitors will automatically calculate the MAP. At times, the MAP may be adequate even when the SBP is low, however, SBP may be used when it is easier to monitor.
- **Capillary refill** is an easy physical exam skill and important indicator of adequate perfusion as a high-fidelity marker for effective resuscitation. It should be performed and recorded as a trend at least every 30 minutes for the unstable septic patient. The proper way to measure capillary refill is to apply pressure down on the fingernail until it blanches (turns white), and after the removal of the pressure, time the nail's return to normal color as compared to the other nails. Normal values are a return to baseline color in three seconds or less. Longer times indicate normal perfusion has not been restored.
- **If a soft tissue infection is suspected,** inspect and monitor the identified site (e.g., cellulitis) for improvement. Use a marker to outline any redness; time and date it. Monitor for any progression beyond the marked lines. If redness worsens after 24 hours or failure to improve within 48 hours, consider changing antibiotics or the need for surgical debridement after consulting telemedicine.
- **Urine output (UOP)** should be maintained at an average of 0.3-0.5mL/kg/hr.
- **Perform and repeat available labs** as indicated. Diagnostics: urine dipstick, malaria tests. Trend: i-STAT, lactate.
- **Initiate telemedicine early** and often and report trends.
- **Monitor overall respiratory status**. Many patients who are critically ill with sepsis will need ventilatory support at some point in their management – see the *Airway Management - PFC CPG*,[21] as well as the PFC reference paper: *"MSMAID" Applying an Anesthesia Checklist to SOF Medicine*.[22] Always be prepared to manage a complex airway with septic patients. Also, see the *CCAT Mechanical Ventilation CPG.* [23]

EARLY TELEMEDICINE

***GOAL**: Gather appropriate and complete information and enlist the help of a critical care and/or surgical expert early in your management.*[24]

The following information, if obtainable, should be prioritized to enable the most effective telemedicine support: subjective comments; objective – vital signs (HR, RR, Systolic BP, MAP, urine output); mental status; skin exam, lactate (if available); treatments administered or available – antibiotics; any other drugs, and the amount and type of fluids given so far.

- Ensure the complete medical history and documentation of any preceding events.
- Communicate capabilities available where you are managing the patient (e.g., by completing the "capabilities checklist" on the *PFC WG Telemedicine Template* on prolongedfieldcare.org and emailing/texting if possible before calling the consultant).
- Document any infected wounds, bites, or other potential sources of infection, etc. Send photographs or real-time video if possible.

EVACUATE TO DEFINITIVE CARE

***GOAL**: Patients identified as being septic should be assigned the highest priority of evacuation to higher levels of medical care.*

Patients with sepsis or with conditions concerning for the deterioration to sepsis will be best managed in a clinical setting conducive to monitoring and addressing multi-organ failure and associated complications. Also, see the *JTS Nursing Intervention - PFC CPG* and *JTS Analgesia and Sedation Management - PFC CPG*.[25]

NUTRITION CONSIDERATIONS

Septic patients are most often in a hypermetabolic state due to the body's efforts to fight off the infection. Nutrition is not the most important consideration in the early treatment. However, given that some patients may require continued treatment in an austere environment, may have pre-existing malnutrition, or may present for treatment after being septic for a period of time, attention must be paid to the patient's nutrition as a part of a treatment plan. This can be difficult if the patient is nauseated and/or vomiting, has an intraabdominal source of infection, resources are severely limited, or the patient's mental status is not conducive to eating and drinking.

Most patients do not require nutritional support when evacuation is anticipated within 72 hours. When evacuation is delayed beyond 72 hours or not possible, adequate nutrition should be sustained as outlined below.

***GOAL**: Goal 25-30kcal/kg/day + 1-1.2gm/kg protein. Most patients with a normal mental status can feed him or herself without the placement of a feeding tube.*

1. Enteral nutrition (oral or administered by orogastric or nasogastric tube) should be withheld in hemodynamically unstable patients (i.e. those on high or increasing doses of vasopressors) due to the risk of causing ischemic GI injury to include perforation.
2. Nasogastric Tube (NGT) should be placed in patients deemed in critical for gastric decompression. If medical evacuation is significantly delayed (greater than 48 – 72 hours) or the patient has been without significant caloric intake for over 3 days (due to delayed presentation), consider starting enteral nutrition (orally if they can take PO safely, via tube if not). If the patient requires continuous vasopressors, avoid the bolus nutrition sources, and opt for a lower volume hourly rate of infusion (10 – 20cc/hr.).
3. At a minimum, confirm presence of gastric placement with auscultation over both lung fields and the abdomen, along with aspiration of gastric contents. Best recommendation is obtaining plain film radiography to confirm proper placement PRIOR to instilling any substances through the tube.
4. Ensure presence of normal bowel sounds prior to initiating any enteral feeding.
5. Enteral feeding is contraindicated in the presence of severe abdominal distension, abdominal pain and/or gastro-intestinal bleeding.

Oral Feed vs Tube Feed

If a patient has a normal mental status they likely can take oral nutrition - do not put a tube down their nose. If they cannot cooperate or tolerate oral feeds, and evacuation is not likely or not possible within 72 hours, consider tube feeds. If tube feeds are initiated without an ability to obtain x-ray verification of placement, monitor for signs of misplacement or GI obstruction very closely (e.g., nausea, increasing abdominal distension or pain) and stop feeding if they occur. Patients require continuous hydration, but those who receive adequate hydration will not experience clinically significant adverse effects from starvation for several days to over a week.

Severe Malnutrition

If someone has signs of severe malnutrition (e.g., local nationals in setting of famine, hostages), obtain telemedicine consultation before starting enteral nutrition. Refeeding syndrome is a life-threatening metabolic and electrolyte derangement that can develop from feeding severely malnourished patients too much, too quickly. It is very difficult to detect in the PFC environment. The first sign may be cardiac collapse from electrolyte derangements which is nearly impossible to resuscitate.

6. Meal supplement drinks are sufficient. 1x Muscle Milk Light bottle contains 150kcal and 28gm protein in 500mL.
7. A more concentrated alternative is to use commercially available protein powder (with similar caloric/protein content per scoop) at 1/4 the recommended concentration and mix until no clumps are visible.
8. Administer tube feeds in small volume boluses (e.g., 60mL via Toomey syringe) 2-4 hours for a goal of 1gm/kg/day protein content.
9. If vomiting or increased abdominal distension occur, hold tube feeds for 6 hours and then try again.
10. For more information, see *JTS Nutrition Support Using Enteral and Parenteral Methods CPG*.[26]

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Casualties receiving PFC or Prolonged Casualty Care (PCC).

INTENT (EXPECTED OUTCOMES)

Prehospital documentation is received by JTS on all PFC and PCC patients.

PERFORMANCE/ADHERENCE MEASURES

- Sepsis patient with >2hr prehospital care that arrives intubated to Role 2 or 3.
- Sepsis patient with >2hr prehospital care requiring dialysis at Role 3 or 4.
- Sepsis patient with >2hr prehospital care that dies in first 30 days.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)
- PFC Flowsheet

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: SEPSIS PATIENT MANAGEMENT CHECKLIST

If sepsis is suspected, the following checklist should be employed to begin treatment and set up a safety net for ongoing patient care:

- ☐ Placement of 2 IV access points (Large bore IV/IO).
- ☐ Collect blood cultures x2 (if available).
- ☐ Start IVF with goal resuscitation of adequate urine output, up to maximum bolus of 30ml/kg (usually about 2-3 Liters). See Resuscitation recommendations.
- ☐ Consider placement of advanced monitoring equipment (if available).
- ☐ Place a Foley catheter.
- ☐ Monitor all vital signs and continuously trend heart rate, blood pressure, respiratory rate, and mental status every 15 minutes on a flowsheet. (See *https://jts.health.mil/index.cfm/PI_CPGs/cpgs*). Temperature and urine output should be documented hourly.
- ☐ Place on oxygen if indicated and available (for SpO2 < 90%).[1]
- ☐ Ensure a secure airway is in place, or the equipment for a definitive airway is on hand along with the elements of M.S.M.A.I.D. (See *JTS Airway Management for Prolonged Field Care CPG*.)
- ☐ Search for the source of infection. Address this as appropriate (wound care, removal of infected catheters, surgical consultation, etc.)
- ☐ Give the most appropriate antibiotics.
- ☐ Call telemedicine consultant early and often.
- ☐ Take/Give Approach: Take – Vital signs, neurologic assessment, wound/ skin infection exams, serum lactate level, urine output (Foley catheter), rapid tests. Give – Antibiotics, Fluids, Oxygen (if available), Vasopressors (with telemedicine).
- ☐ If providing nutrition, monitor for signs of GI upset or obstruction: nausea, abdominal pain, and abdominal distension.

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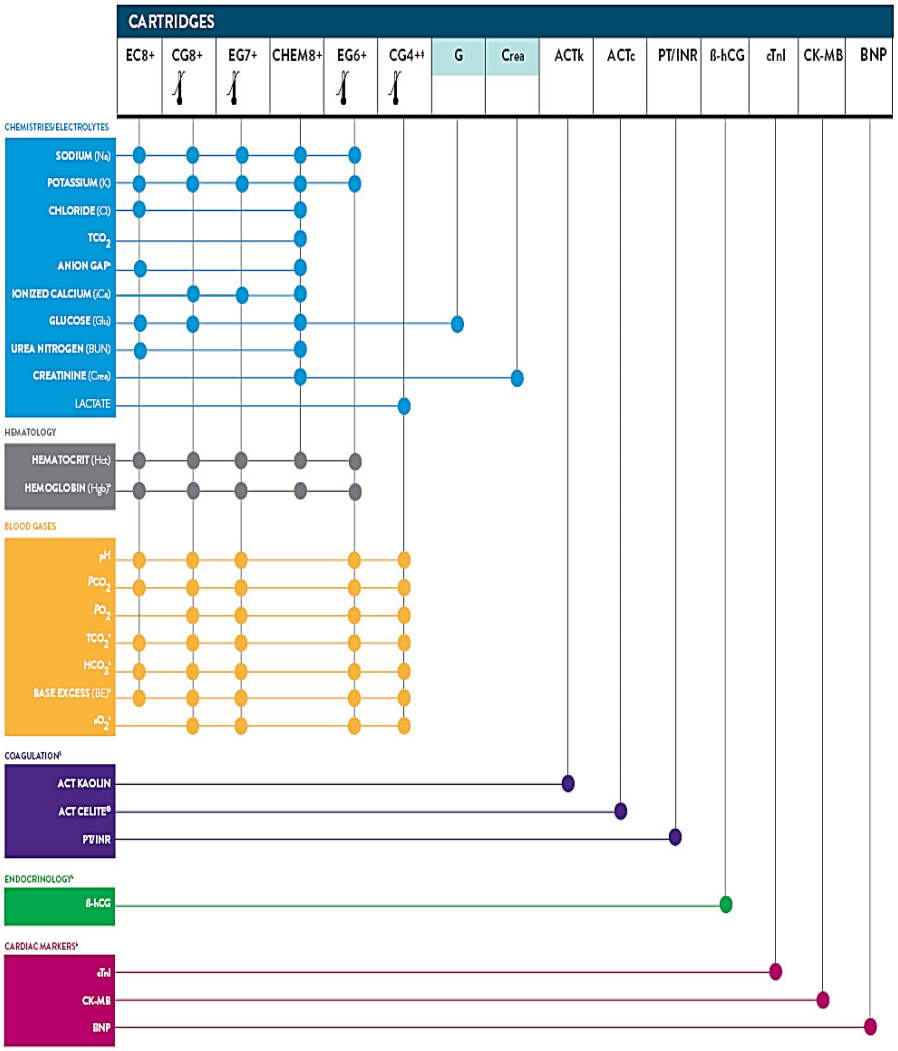
APPENDIX B: I-STAT LAB VALUES

The laboratory values shown in the table are a composite of the laboratory values, by cartridge, that i-STAT has available. Lab values that may indicate sepsis are elevated lactic acid (lactate), procalcitonin (PCT), and white blood cell (WBC) count. See the *i-STAT Portable Blood Analyzer in Austere Locations CPG*. The values represent a peripheral venous collection. Lab results should be compared to the i-STAT normal range shown in the reference table. *(Preprinted with permission from Abbott Labs, July 2020)*



EXPECTED VALUES			
ANALYTE	REPORTABLE RANGE	REFERENCE RANGE, ARTERIAL	REFERENCE RANGE, VENOUS
Sodium (Na)	100-180 mmol/L	138-146 mmol/L	138-146 mmol/L
Potassium (K)	2.0-9.0 mmol/L	3.5-4.9 mmol/L	3.5-4.9 mmol/L
Chloride (Cl)	65-140 mmol/L	98-109 mmol/L	98-109 mmol/L
TCO_2	5-50 mmol/L	23-27 mmol/L	24-29 mmol/L
Anion Gap[a]	(-10)-(+99) mmol/L	10-20 mmol/L	10-20 mmol/L
Ionized Calcium (iCa)	0.25-2.50 mmol/L	1.12-1.32 mmol/L	1.12-1.32 mmol/L
Glucose (Glu)	20-700 mg/dL	70-105 mg/dL	70-105 mg/dL
Urea Nitrogen (BUN)	3-140 mg/dL	8-26 mg/dL	8-26 mg/dL
Creatinine (Crea)	0.2-20.0 mg/dL	0.6-1.3 mg/dL	0.6-1.3 mg/dL
Lactate[b]	0.30-20.0 mmol/L	0.36-1.25 mmol/L	0.90-1.70 mmol/L
Hematocrit (Hct)	15-75 %PCV	38-51 %PCV	38-51 %PCV
Hemoglobin (Hgb)[a]	5.1-25.5 g/dL	12-17 g/dL	12-17 g/dL
pH‡	6.50-8.20‡	7.35-7.45	7.31-7.41
PCO_2‡	5-130 mmHg‡	35-45 mmHg	41-51 mmHg
PO_2‡	5-800 mmHg‡	80-105 mmHg	
TCO_2[a]	5-50 mmol/L	23-27 mmol/L	24-29 mmol/L
HCO_3[a]	1.0-85.0 mmol/L	22-26 mmol/L	23-28 mmol/L
Base Excess (BE)a	(-30)-(+30) mmol/L	(-2)-(+3) mmol/L	(-2)-(+3) mmol/L
sO_2[a]	0-100 %	95-98 %	
ACT Kaolin	50-1000 Seconds	74-137 Seconds (Prewrm)	74-137 Sec. (Prewrm)
ACT Celite®	50-1000 Seconds	74-125 Seconds (Prewrm)	74-125 Sec. (Prewrm)
PT/INR	0.9-8.0 INR[c]		
ß-hCG	5.0-2000.0 IU/L		<5 IU/L
cTnI	0.00-50.00 ng/mL		0.00-0.08 ng/mL[d]
CK-MB	0.0-150.0 ng/mL		0.0-3.5 ng/mL[e]
BNP	15-5000 pg/mL		<15-50 pg/mL[e]

[a] Calculated-note that TCO_2 is measured on CHEM8+ cartridge and calculated on all others.
[b] See individual cartridge web pages for intended use information.
Celite is a registered trademark of Celite Corporation, Santa Barbara, CA for its diatomaceous earth products.
= CLIA waived: granted waived status for lithium heparin whole-blood venous samples only collected in a lithium heparin evacuated tube.

‡ Reportable ranges for the (blue) CG4+ cartridge are: pH = 7.00-7.70; PO_2 = 15-530; PCO_2 = 15-130
[c] Performance characteristics have not been established for INR values over 6.0.
[d] Represents the 0-99% range of results.
[e] Represents the 0-95% range of results.

APPENDIX C: ABNORMALITIES DETECTION

Urine Dipstick: A dipstick — a thin, plastic stick with strips of chemicals on it — is placed in the urine to detect abnormalities. The chemical strips change color if certain substances are present or if their levels are not normal. The color variation often is indicative of how severe the abnormality is. Urine dipsticks are another tool and indicator to measure a patient's well-being. Its values should be included in the "whole patient" approach to the medical evaluation. A dipstick test checks for:

- **Acidity (pH).** The pH level indicates the amount of acid in urine. Abnormal pH levels may indicate a kidney or urinary tract disorder or a potential systemic infection – sepsis.

- **Concentration**. A measure of concentration, or specific gravity, shows how concentrated particles are in your urine. A higher than normal concentration often is a result of not drinking enough fluids. In the setting of sepsis, it is a sign of clinically significant volume depletion.

- **Protein**. Low levels of protein in urine are normal. Small increases in protein in urine usually are not a cause for concern, but larger amounts may indicate a kidney problem.

- **Sugar**. Normally the amount of sugar (glucose) in urine is too low to be detected. Very high levels of glucose, especially when ketones are also elevated and pH decreased, can indicate diabetic ketoacidosis which may mimic sepsis. This can occur in individuals who were not previously aware they are diabetic and is a life-threatening condition, obtain telemedicine consult.

- **Ketones**. As with sugar, high levels of ketones detected in your urine could be a sign of diabetic ketoacidosis. Ketones in urine may also be a sign of malnutrition and protein-calorie deficit in the septic patient that should prompt consideration of starting caloric intake or enteral nutrition.

- **Bilirubin**. Bilirubin is a product of red blood cell breakdown or bile synthesized in the liver. Normally, bilirubin is carried in the blood and passed into the liver, where it is conjugated and becomes part of bile. Bilirubin in your urine may indicate liver damage, bile duct obstruction, or hemolysis (e.g., distributed intravascular coagulopathy).

- **Evidence of infection**. If either nitrites or leukocyte esterase — a product of white blood cells — is detected in your urine, it may be a sign of a urinary tract infection or systemic infection – sepsis.

- **Blood**. Blood in your urine requires additional testing — it may be a sign of kidney damage, infection, kidney or bladder stones, kidney or bladder cancer, or blood disorders.

APPENDIX D: MALARIA RAPID TEST & MICROSCOPY

Reprinted with permission from Abbott Labs, July 2020.

BINAXNOW®

The BinaxNOW® Malaria test is a rapid and simple diagnostic test that can differentiate a deadly P. falciparum infection from a pan-malarial infection caused by P. vivax, P. ovale or P. malariae in 3 simple steps using 1 reagent. Typically, the limiting factor for mass-testing is the amount of reagent on-hand.

- Results appear in 15 minutes
- Sensitivity: 99.7% (P.f.); 93.5% (P.v.)
- Specificity: 94.2% (P.f.); 99.8% (P.v.)

Directions for BinaxNOW Use

Step 1	Step 2	Step 3	Step 4
Apply 15uL of blood to the bottom half of the purple pad.	Apply 2 drops of Reagent to the white pad immediately below where the blood was applied.	Apply 4 drops of Reagent to the pad located at the top of the left-hand side of the test card.	When the blood sample reaches the base of the white absorbent pad at the top of the test strip, close device and read after 15 minutes.

Binaxnow Results Table

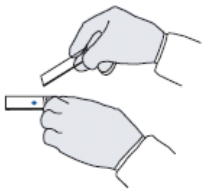
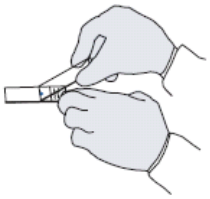
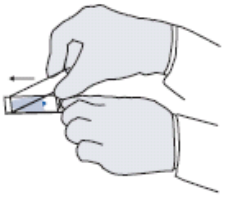
Positive P. Falciparum Mixed	Positive P. Falciparum	Positive P. Vivax P. Ovale P. Malariae	Negative

MICROSCOPY

When done correctly, microscopic examination of thick and thin blood smears is the most reliable test for malaria. Blood smears are taken most often from a finger prick and a few drops of blood. Thick and thin blood smears allow direct visualization of parasites and their reproductive derivatives – schizonts in malaria. See *U.S. Department of Defense. Special Operations Forces Medical Handbook. 2011.*

- A thick blood smear is a drop of blood on a glass slide. Thick blood smears are most useful for detecting the presence of parasites, because they examine a larger sample of blood. (Often there are few parasites in the blood at the time the test is done).
- A thin blood smear is a drop of blood that is spread across a large area of the slide. Thin blood smears help providers discover what species of malaria is causing the infection.
- The two smears can work in tandem if a thick and thin smear is made. This method allows the provider to observe both thick and thin smears and find the blood density that is most likely to yield visualization of the parasite to the given observer.
- If a high index of suspicion exists for malaria in a given patient, but microscopy does not reveal an obvious malarial infection, serial thick and thin smears can be repeated every 8 or 24 hours depending on the severity of the case.

Making a thick and thin smear

Step 1	Step 2	Step 3	Step 4	Step 5
Bring a clean spreader slide, held at a 45-deg. angle, toward the drop of blood on the specimen slide.	Wait until the blood spreads along the entire width of the spreader slide.	While holding the spreader slide at the same angle, push it forward rapidly and smoothly.	Wait until the smear is completely dry. Fix the thin film with 100% (absolute) methanol.	When the film is completely dry, stain with 7.5% Giemsa stain for 15 minutes.
				

The thick and thin film should be air-dried, fixed with 100% (absolute) methanol, and allowed to dry before staining with 7.5% Giemsa stain for 15 minutes. Plasmodium parasites are always intracellular, and they demonstrate, if stained correctly, blue cytoplasm with a red chromatin dot (see images 1-4 below). Common errors in reading malaria films can be caused by platelets overlying a red blood cell, concern regarding missing a positive slide, and misreading of artifacts as parasites. The slide is best read by starting at the thin end of the slide and moving it towards the thick side until the RBCs are side by side, but NOT overlapping. This will give the observer the highest concentration of RBCs in view, giving him or her the highest probability of identifying the parasite. Move the slide along this plane of side-by-side RBCs to accurately rule out or in a malarial parasitic infection (Image 1). If the malaria parasite is identified, begin appropriate anti-malaria/anti-parasite treatment immediately in conjunction with the antibiotic therapies (minimum, better, best) mentioned above.

Malaria parasites

Images 2-4 demonstrate plasmodium within cells with the characteristic "signet ring" sign.

Image 1. *Malaria parasites are identifiable by their blue stain inside the cells. This picture shows an excellent example of a properly prepared thick/thin smear – the cells are side by side without overlapping.*

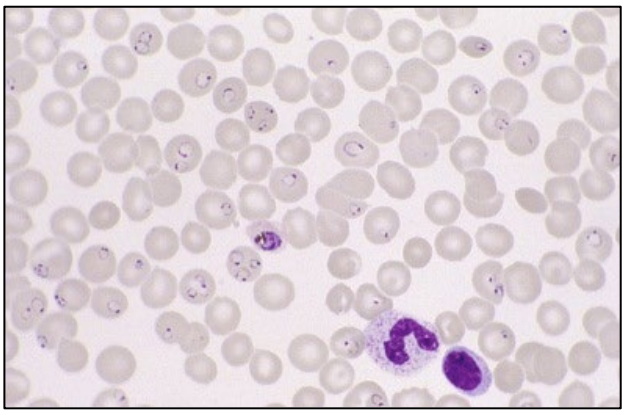


Image 2

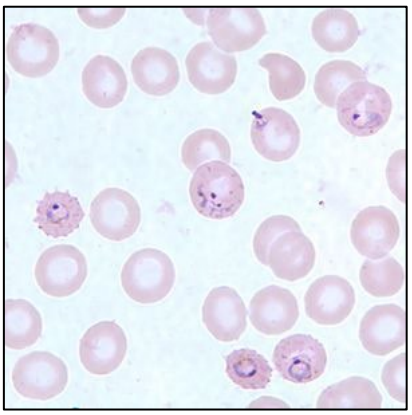


Image 3

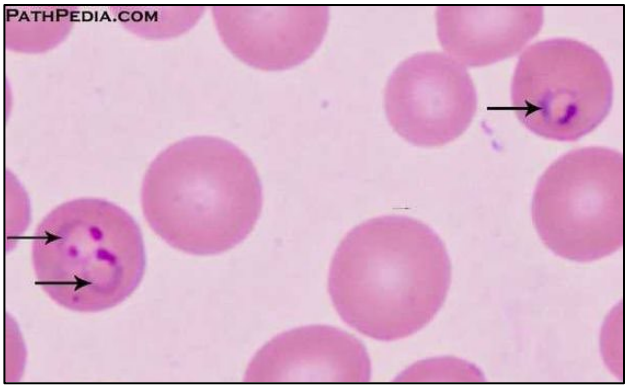
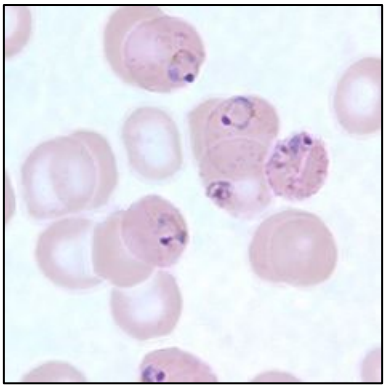


Image 4



Images 2-4 from cdc.gov; image 3 from pathpedia.com.

APPENDIX E: LACTATE

Lactate can be measured with the CG4 i-STAT cartridge. This specific cartridge must be stored in a temperature-controlled environment. Lactate can also be measured using a lactate-specific device but many are not approved for medical management of critical patients.[1]

Adding lactate to other resuscitation endpoints is beneficial, however patients should be monitored using a "whole patient" approach. He or she could be doing well clinically with an adequate blood pressure and capillary refill, good urine output, and down-titrating vasopressors, but continues to have a persistently elevated lactate level. There are many reasons for this, some of which do not require a clinical response, only further monitoring. Lactate levels have a direct impact on a patient's pH (acidosis), however the main adverse effects of acidosis are a) decreased cardiac output and vascular "tone," which will be seen as persistent hypotension and b) impaired coagulation, which will be seen as bleeding despite adequate blood product resuscitation and source control. In general, these effects do not occur at a pH above 7.2 (which does not correlate directly to a specific lactate level).

If lactic acid levels are available, they should be integrated into patient monitoring as follows:

- Trend lactic acid levels at a frequency of every 4 – 6 hours. Lactate improvement will lag behind improvement in vital signs, mental status, and urine output.
- If patient is under-resuscitated, or resistant to resuscitation, vital signs and organ dysfunction assessments will continue to be abnormal, with no appreciable response, and lactate will remain elevated.
- If other markers of resuscitation are improving and the patient is clinically improving, but lactate is not decreasing or is increasing, it could be an indication of tissue reperfusion (flushing out vascular beds that have not been perfused due to shock). Keep trending lactate, and if it remains elevated or is increasing, this could be an indication of a source of infection that has not been adequately addressed and may require a change in antibiotic regimen, and/or surgical intervention. Obtain telemedicine consult.

1. *Bonaventura JM, Sharpe K, Knight E, et al. Reliability and accuracy of six hand-held blood lactate analysers. J Sports Sci Med. 2015 Mar 1;14(1):203-14.*

APPENDIX F: EPINEPHRINE (NOREPINEPHRINE) - VASOPRESSOR GUIDE

Consider starting low dose vasopressors – either epinephrine, or norepinephrine if available -after 30mL/kg of IVF and no changes in MAP, urine output or mentation.[1] Epinephrine can improve blood pressure by a) vasoconstriction and b) increasing cardiac contractility, thus improving cardiac output.[2] Vasopressors are rarely used outside of a critical care setting and use in an austere environment indicates a dire situation and must be monitored extremely closely. The dose of either epinephrine or norepinephrine are the same for drip calculations. Epinephrine is presented as it is far more available in austere practice settings. These are presented as low-dose starting points and any adjustments should be directly under telemedicine guidance. Of note: if monitoring, levels of lactate may rise with use of epinephrine as a vasopressor.

Epinephrine, as an IV or IO push-dose: A 10mL syringe consisting of 9mL of Normal Saline (0.9% NaCl) with 1mL of cardiac epinephrine (1:10,000 or 100mcg/mL). Administer to acutely correct a blood pressure indicative of shock (systolic <90). Administer a lower-end dose (0.5 – 1mL) while preparing a longer-term IVF drip (below).

- Concentration: 10mcg epinephrine/mL
- Onset: 1 minute
- Duration: 5 – 10 minutes
- Dose: 0.5 – 2mL every 2 – 5 minutes (5 – 20mcg)
- Administration: very slow IV push. 1 cc/min for 10 minutes. Rapid administration can cause rebound tachycardia, hypertensive emergency, and cardiac arrest.

Epinephrine as a vasopressor drip: Epinephrine; 4mcg/min bag reference chart. This dose is a starting/maintenance point in the application of an epinephrine (vasopressor) IV drip bag – Epinephrine Challenge. Gold-standard hospital practice utilizes a central line for this intervention; however, in an austere setting, peripheral antecubital access is acceptable (humeral, tibial, and sternal IO are also acceptable if flow rate can be precisely managed). The drip rate should be adjusted up, down or discontinued depending on the perfusion or vitals status of the patient. Once a vasopressor is started, the patient must be constantly monitored. Whenever possible, telemedicine consultation is required when vasopressor support is initiated.

Epinephrine 1:10,000 (Adrenaline) or Norepinephrine (Levophed) Drip Table

0.9% NaCl IVF Bag Size	Add to bag: EPI (or NOREPI): 1:10,000 (0.1 mg or 100mcg)/mL	Starting Dose (mcg/min)	DRIP SET:10gtts (Drops/mL) DRIP RATE: (Drops/min or gtts/min)	DRIP SET: 15gtts (Drops/mL) DRIP RATE: (Drops/min or gtts/min)
50mL	1mL (100mcg)	4 mcg/min	20 drops/min	30 drops/min
100mL	2mL (200mcg)	4 mcg/min	20 drops/min	30 drops/min
250mL	5mL (500mcg)	4 mcg/min	20 drops/min	30 drops/min
500mL	10mL (1mg)	4 mcg/min	20 drops/min	30 drops/min
1000mL (1L)	20mL (2mg)**	4 mcg/min	20 drops/min	30 drops/min

***This is the least recommended approach as it commits a high volume of epinephrine to a large bag. If the patient's vital signs (BP/MAP/HR) stabilize, the bag must be discontinued and the medic risks wasting some of his or her resources – "you can mix a drug in an IV bag, but you can't take it out."*

Key point: If administering epinephrine infusion via a peripheral IV, monitor the IV site with every vital signs check for signs of redness, swelling or induration (firm, chord-like feeling of vessel above IV site). If any of these are present, epinephrine may be leaking out of the IV ("extravasating") which can cause permanent scarring and damage to the vessel. Stop the infusion immediately and seek telemedicine consultation.

WARNING

Vasopressors are extremely potent medications. Besides the risk associated with peripheral infusions, dosing must be strictly monitored, and care must be taken to ensure proper dose is being consistently delivered. Providers should expect to see increases in both heart rate and blood pressure, but extreme tachycardia (as a sign of malignant cardiac rhythms) should prompt stopping the infusion and consulting telemedicine advice. Careful medical history should be obtained and patients with hypertension and/or coronary artery disease should only be administered these medications under strict guidance.

Use IV hydrocortisone, 100 mg every 8 hours, for at least 3 days in a military-aged male to treat septic shock in patients if adequate fluid resuscitation and vasopressor therapy are not able to restore hemodynamic stability. Due to the low volume and quality of evidence with this intervention, telemedicine is required before IV hydrocortisone is initiated as a treatment.[3]

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1. Russell J, Gordon A, Walley K. Early may be better: early low-dose norepinephrine in septic shock. American Journal of Respiratory and Critical Care Medicine Vol. 199, No. 9 May 01, 2019; 1049–1051.
2. Farkas J. Epinephrine Challenge in Sepsis: An Empiric Approach to Catecholamines. EMCrit 2016. https://emcrit.org/pulmcrit/epi/ Accessed Oct 2020.
3. Gibbison B, López-López JA, Higgins JP, et al. Corticosteroids in septic shock: a systematic review and network meta-analysis. Crit Care. 2017 Mar 28;21(1):78.

APPENDIX G: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

U.S. ARMY AEROMEDICAL EVACUATION

STANDARD MEDICAL OPERATING GUIDELINES (SMOG)

CY23 Version

Published

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Effective 1 FEB 2023

Summary of Changes Located at End of Document

INTRODUCTION

The CY 2023 SMOG release marks the last year of the current format. The Aeromedical Evacuation community provided developmental feedback leading to a redesign of current written medical guidance and/or policy. Be assured all future changes are a continued result of collaboration between Emergency Medicine professionals, experienced Flight Medics, Aeromedical Physician Assistants, Critical Care Nurses, and Flight Surgeons across the Army. There is close coordination in the development of these guidelines with the Joint Trauma System, and the Defense Committees on Trauma. Our shared goal is to ensure the highest quality enroute care possible and to standardize care across all evacuation and emergency medical pre-hospital units. It is our vision that all these enhancements and improvements will advance enroute care across the services and the Department of Defense.

Unit Medical Trainers, Medical Standardization Instructors, Medical Flight Instructors and Medical Directors will evaluate Critical Care Flight Paramedics (CCFP) ability to follow and execute the medical instructions herein. These medical guidelines are intended to guide CCFPs and prehospital professionals in the response and management of emergencies and the care and treatment of patients in both garrison and combat theater environments. Unit medical providers are not expected to employ these guidelines blindly. Unit medical providers are expected to manipulate and adjust these guidelines to their unit's mission and medical air crew training / experience. Medical directors or designated supervising physicians will endorse these guidelines as a baseline, appropriately adjust components as needed, and responsibly manage individual unit medical missions within the scope of practice of their Critical Care Flight Paramedics, Enroute Critical Care Nurses, and advanced practice aeromedical providers.

CCFPs should administer medications as listed in the guidelines unless their medical director and/or supervising physician orders a deviation. Other medications may be added, so long as the unit supervising physician and/or medical director approves them.

This manual also serves as a reference for physicians providing medical direction and clinical oversight to the CCFP. Treatment direction, which is more appropriate to the patient's condition than the guideline, should be provided by the physician so long as the CCFP scope of practice is not exceeded.

Any medical guideline that is out of date or has been found to cause further harm will be updated or deleted immediately. The Department of Aviation Medicine (DAM) serves as the managing editor of the SMOG and is responsible for content updates, managing the formal review process, and identifying review committee members for the annual review.

The Standard Medical Operating Guidelines are intended to provide medical procedural guidance and is in compliment to other Department of Defense and Department of the Army policies, regulatory and doctrinal guidance. Nothing herein overrides or supersedes laws, rules, regulation or policies of the United States, DoD or DA.

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PROCEDURE

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Standard Medical Operating Guidelines are found at the following website:

https://www.milsuite.mil/book/groups/department-school-of-army-aviation-medicine

Also available, along with all fillable evacuation forms and AARs on the Joint Trauma System website:
https://jts.amedd.army.mil/index.cfm/PI_CPGs/cpgs

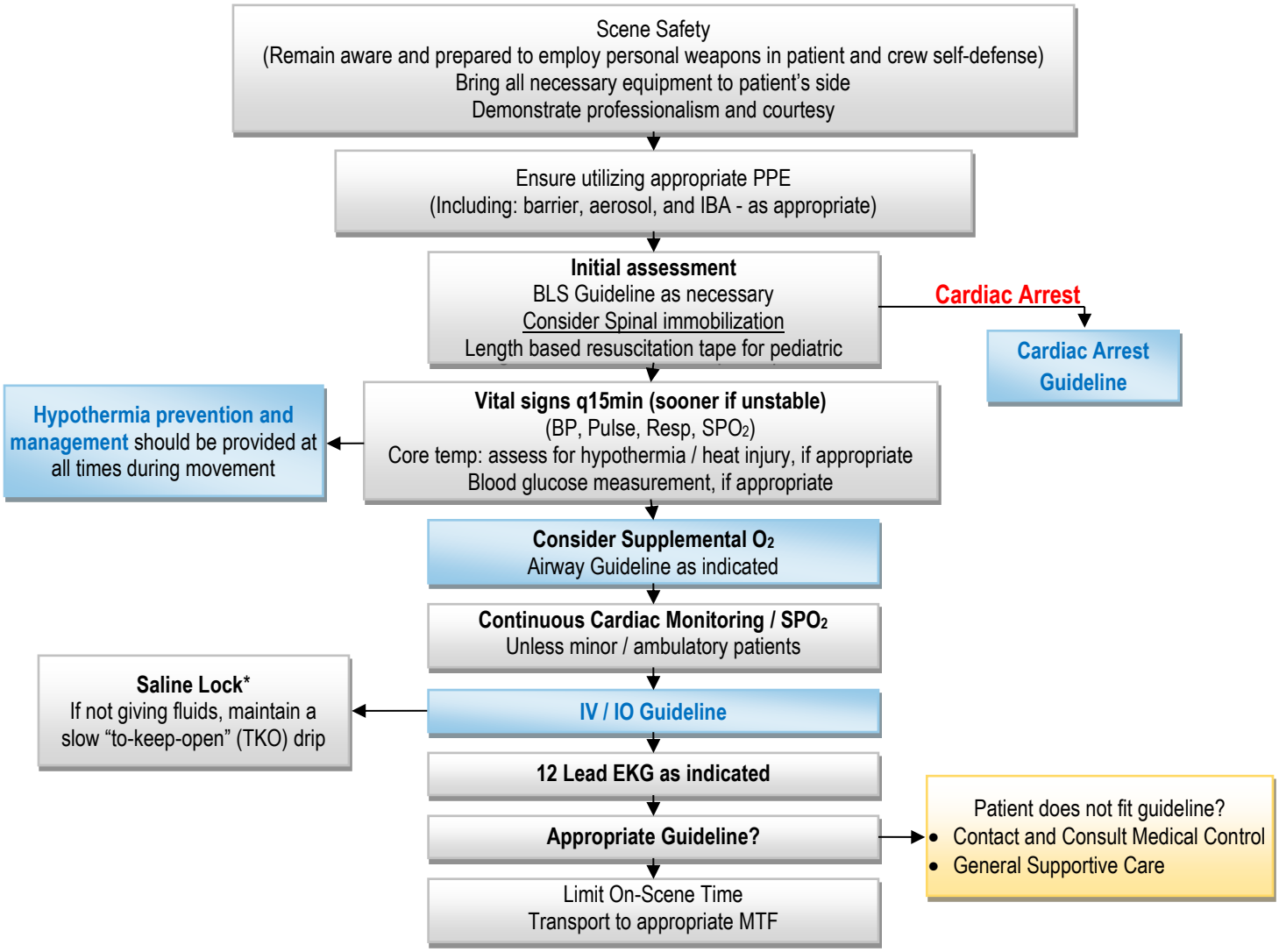
https://jts.amedd.army.mil/index.cfm/documents/forms_after_action

All comments and/or recommendations should be sent to:

medcoesaamoperations@army.mil

with the subject line "CCFP-SMOG"

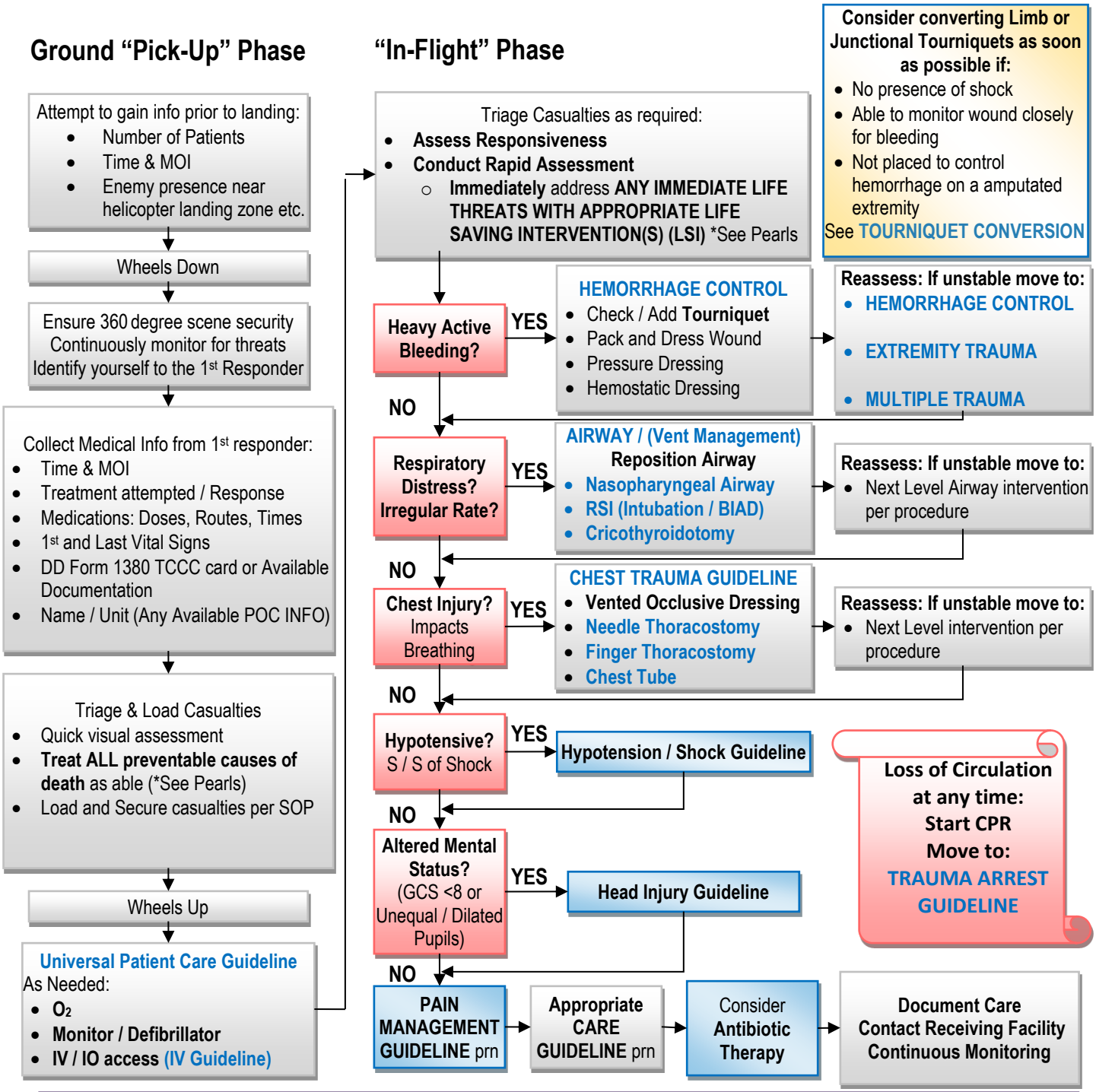
UNIVERSAL PATIENT CARE


Scene Safety
(Remain aware and prepared to employ personal weapons in patient and crew self-defense)
Bring all necessary equipment to patient's side
Demonstrate professionalism and courtesy
Ensure utilizing appropriate PPE
(Including: barrier, aerosol, and IBA - as appropriate)
Initial assessment
BLS Guideline as necessary
Consider Spinal immobilization
Length based resuscitation tape for pediatric
Cardiac Arrest
Cardiac Arrest Guideline
Hypothermia prevention and management should be provided at all times during movement
Vital signs q15min (sooner if unstable)
(BP, Pulse, Resp, SPO2)
Core temp: assess for hypothermia / heat injury, if appropriate
Blood glucose measurement, if appropriate
Consider Supplemental O2
Airway Guideline as indicated
Continuous Cardiac Monitoring / SPO2
Unless minor / ambulatory patients
Saline Lock*
If not giving fluids, maintain a slow "to-keep-open" (TKO) drip
IV / IO Guideline
12 Lead EKG as indicated
Appropriate Guideline?
Patient does not fit guideline?
Contact and Consult Medical Control
General Supportive Care
Limit On-Scene Time
Transport to appropriate MTF

Pearls:

- *Blood/Fluid boluses given in trauma victims should be done in accordance with hypotensive resuscitation guidelines – see multiple trauma protocol.
- General supportive measures include: Airway / Respiratory support, continuous hemodynamic monitoring with SPO_2 and $EtCO_2$ as appropriate, Supplemental O_2 PRN, IV Fluid boluses, Pain control PRN.
- All patients should have complete vital signs recorded.
- All patient encounters should be recorded on appropriate care documentation sheets per theater policies, unit SOPs and/or in accordance with JTS Documentation CPG at end of a patient encounter.
- Any mishaps / errors should be brought to attention of the medical control ASAP.
- Contact medical control for any necessary assistance when feasible.

TACTICAL EVACUATION



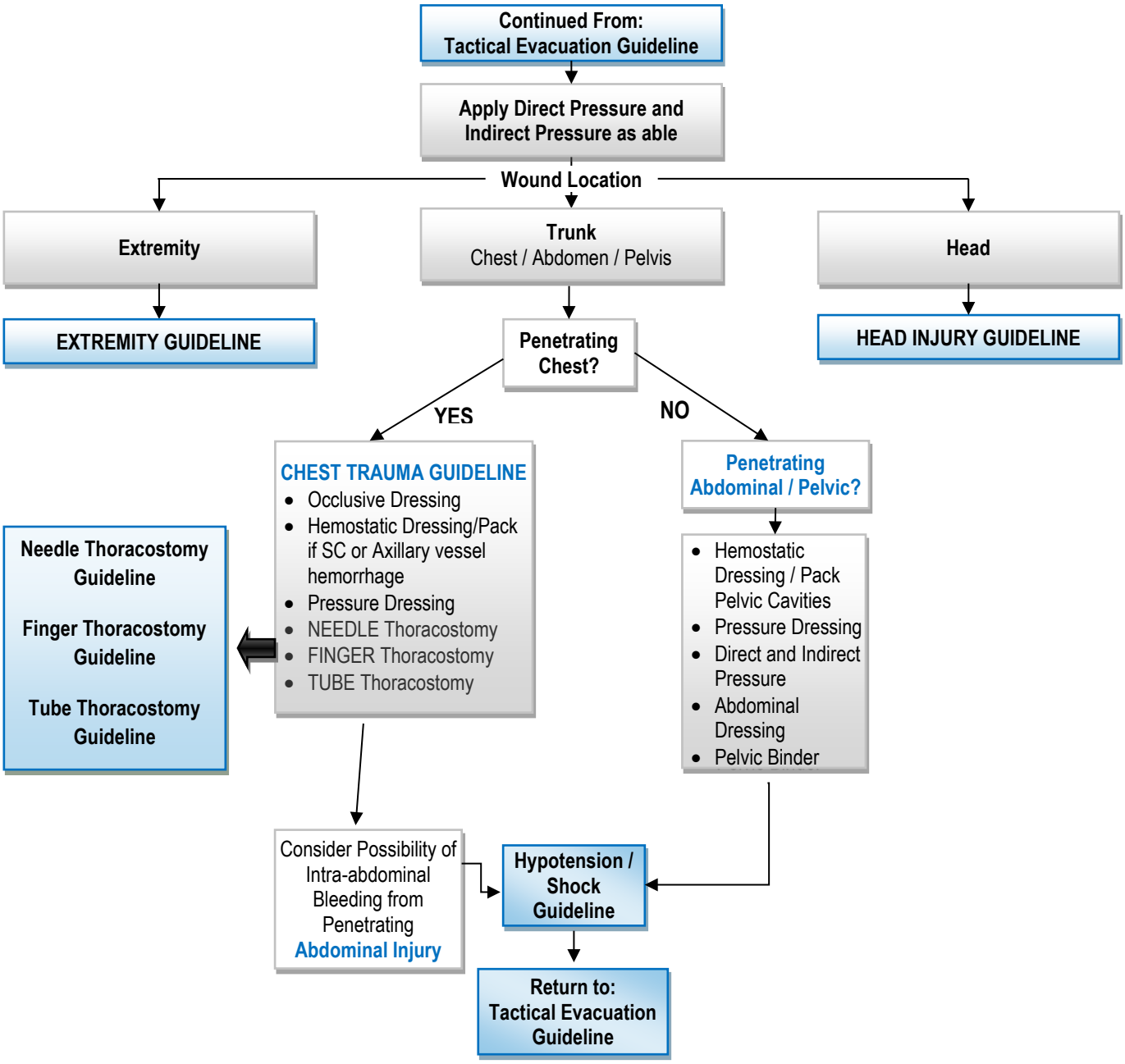
Pearls:

- ***If the tactical situation permits, all known preventable causes of death should be addressed prior to casualty transfer to an air ambulance (e.g., accessible sources of major hemorrhage, tension pneumothorax, and airway obstruction).**
- **Replace any limb tourniquets placed over the uniform (Hasty Tourniquet) with one applied directly to the skin (Deliberate), 2-3 inches above wound.**
- Goal < 5 minutes time on scene prior to wheels up.

HEMORRHAGE

Signs and Symptoms in a Trauma Patient

- **Obvious Arterial Bleeding**
- **Blood Pooling / Soaked Bandages**
- **Venous Bleeding from Extensive Penetrating Wounds** (Multiple fragments)
- **Tachycardia**
- **Distended / Tender Abdomen**
- **Shortness of Breath / Difficulty Breathing / Tachypnea**
- **Decreased LOC**
- **Signs / Symptoms Shock**
- **Hypotension**

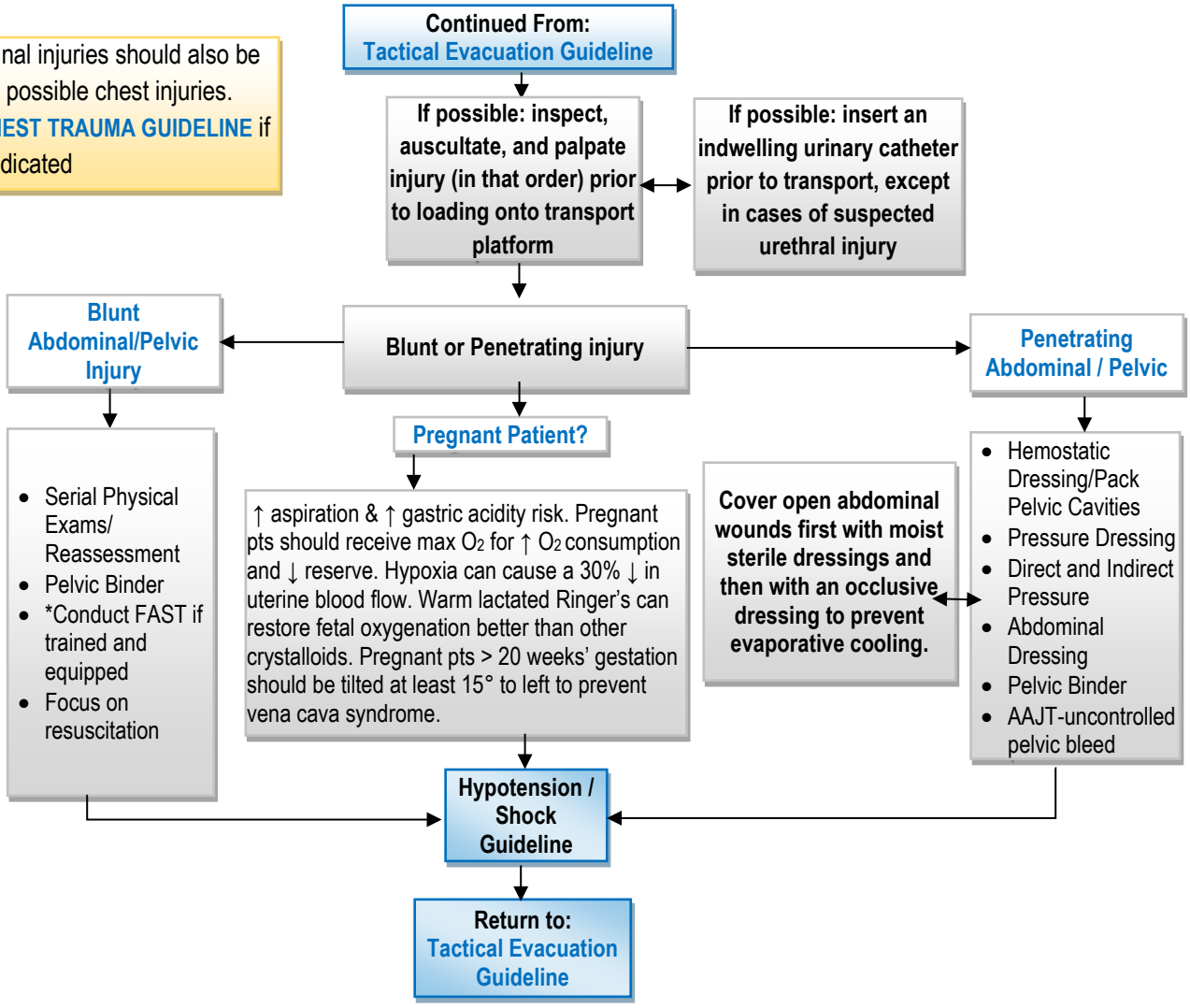


ABDOMINAL INJURY

Signs and Symptoms

- **Altered mental status**
- **Tachycardia**
- **Absence of palpable pulses**
- **Pale, moist, and mottled skin**
- **Poor peripheral perfusion**
- **Hypotension**
- **Hematuria**
- **Pain, Tenderness, Distention, Dissymmetry**
- **Absent/Diminished bowel sounds**
- **Grey Turner Sign**
- **Cullen Sign**
- **Kehr's Sign**

All Abdominal injuries should also be considered possible chest injuries. Consult **CHEST TRAUMA GUIDELINE** if S/Sx are indicated


Continued From:
Tactical Evacuation Guideline
If possible: inspect, auscultate, and palpate injury (in that order) prior to loading onto transport platform
If possible: insert an indwelling urinary catheter prior to transport, except in cases of suspected urethral injury
Blunt or Penetrating injury
Blunt Abdominal/Pelvic Injury
Penetrating Abdominal / Pelvic
Pregnant Patient?
Serial Physical Exams/ Reassessment
Pelvic Binder
*Conduct FAST if trained and equipped
Focus on resuscitation
↑ aspiration & ↑ gastric acidity risk. Pregnant pts should receive max O2 for ↑ O2 consumption and ↓ reserve. Hypoxia can cause a 30% ↓ in uterine blood flow. Warm lactated Ringer's can restore fetal oxygenation better than other crystalloids. Pregnant pts > 20 weeks' gestation should be tilted at least 15° to left to prevent vena cava syndrome.
Cover open abdominal wounds first with moist sterile dressings and then with an occlusive dressing to prevent evaporative cooling.
Hemostatic Dressing/Pack Pelvic Cavities
Pressure Dressing
Direct and Indirect Pressure
Abdominal Dressing
Pelvic Binder
AAJT-uncontrolled pelvic bleed
Hypotension / Shock Guideline
Return to:
Tactical Evacuation Guideline

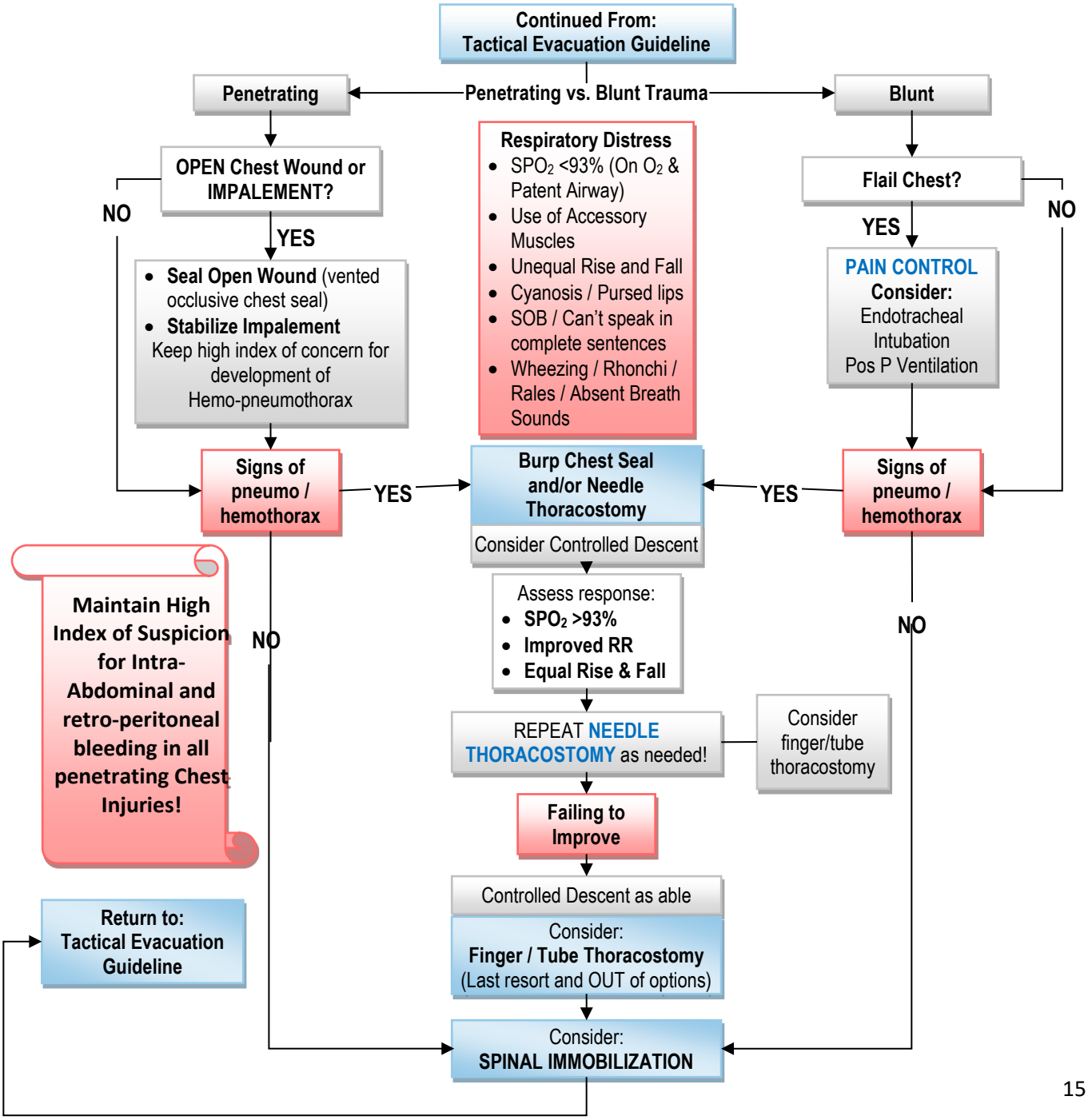
Pearls:

- *FAST Cannot reliably exclude clinically significant injuries, but may provide reasonable indications of intra-abdominal hemorrhage which requires surgical intervention
- **Pain management should not be withheld.
- Lateral contusions (seatbelt sign) associated with a 20% occurrence of internal injury and should alert the CCFP to possible internal injury
- Presence of pregnant uterus should be determined. Traumatic injuries to pregnant patients is further complicated by physiological changes experienced by the patient. Some changes can mimic shock (heart rate can increase by 20 BPM, blood volume increases by 50% during mid-pregnancy, and can experience relative anemia from hemodilution.) Due to the increase in blood flow to the uterus, risk of massive blood loss is greatly increased with trauma to the bony pelvis. At term, the placenta/uterus can perfuse approximately 600-800 mL of blood per minute.

CHEST TRAUMA

Signs and Symptoms of Chest Trauma

- **Difficulty Breathing:** Cyanosis / Pursing of lips / Accessory muscle involvement
- **Rapid Respirations with SPO_2 decreasing or <93%** (Trauma: In Flight and on O_2)
- **Flail Chest**
- **Unequal Rise and Fall**
- **Open Wound / Impalement Over Thorax**
- **Penetrating Abdominal Wound**
- **Bruising Across Chest or Base of Neck**
- **Subcutaneous Emphysema or Deviated Trachea**



EXTREMITY TRAUMA

Signs and Symptoms:
- **Pain / Swelling**
- **Deformity**
- **Altered Sensation / Function**
- **Diminished Pulse / Cap Refill**
- **Decreased Temperature**
- **Bleeding**

Differential Diagnosis:
- **Abrasion**
- **Contusion**
- **Multi-trauma**
- **Fracture**
- **Dislocation**
- **Laceration**
- **Sprain / Strain**
- **Amputation**

Continued From: Tactical Evacuation Guideline

Multiple Injury Sites — YES → **Multiple Trauma Guideline**

NO

Heavy Active Bleeding? — YES →

HEMORRHAGE CONTROL
- Check / Add **Tourniquet (Add DELIBERATE tourniquet if HASTY tourniquets only in place)**
- Pack and Dress Wound
- Pressure Dressing
- Hemostatic Dressing

NO

IV / IO Guideline

Pain Control Guideline

Wound Care / Protection
- Bandage and Cover Injuries
- Immobilize Extremity
- Ice (if available) for Edema

Fluid Resuscitation
- Whole Blood (if available)
- pRBCs and plasma (if available)
- Platelets (If authorized)
- Crystalloid (LR/NS)
- PlasmaLyte A

After Bleeding Controlled:
If Hypotensive or showing signs / symptoms of hypotension or shock
Move immediately to:
HYPOTENSION / SHOCK Guideline

Was it Amputated?

- Clean amputated part
- Wrap in sterile dressing damp with Normal Saline
- Place in plastic bag / air tight container
- Place limb in sealed container in ice bath slurry if available
- Transport with Patient
- Pelvic Binder for Explosive Mechanisms

Consider converting Limb or Junctional Tourniquets as soon as possible if:
- No presence of shock
- Able to monitor wound closely for bleeding
- Not placed to control hemorrhage on a amputated extremity

See TOURNIQUET CONVERSION

Pearls:
- Evaluate and document neurovascular status in all fractures / dislocations.
- Never attempt to reduce an open fracture unless you have a confirmed loss of pulse.
- Blood loss can be severe and concealed in long bone fractures – especially the femur.
- Tourniquets should be used without hesitation to control major bleeding. Use only CoTCCC Approved Tourniquets!
- Limb and junctional tourniquets should be converted to hemostatic or pressure dressings as soon as possible if three criteria are met: the casualty is not in shock; it is possible to monitor the wound closely for bleeding; and the tourniquet is not being used to control bleeding from an amputated extremity. Every effort should be made to convert tourniquets in less than 2 hours if bleeding can be controlled with other means.

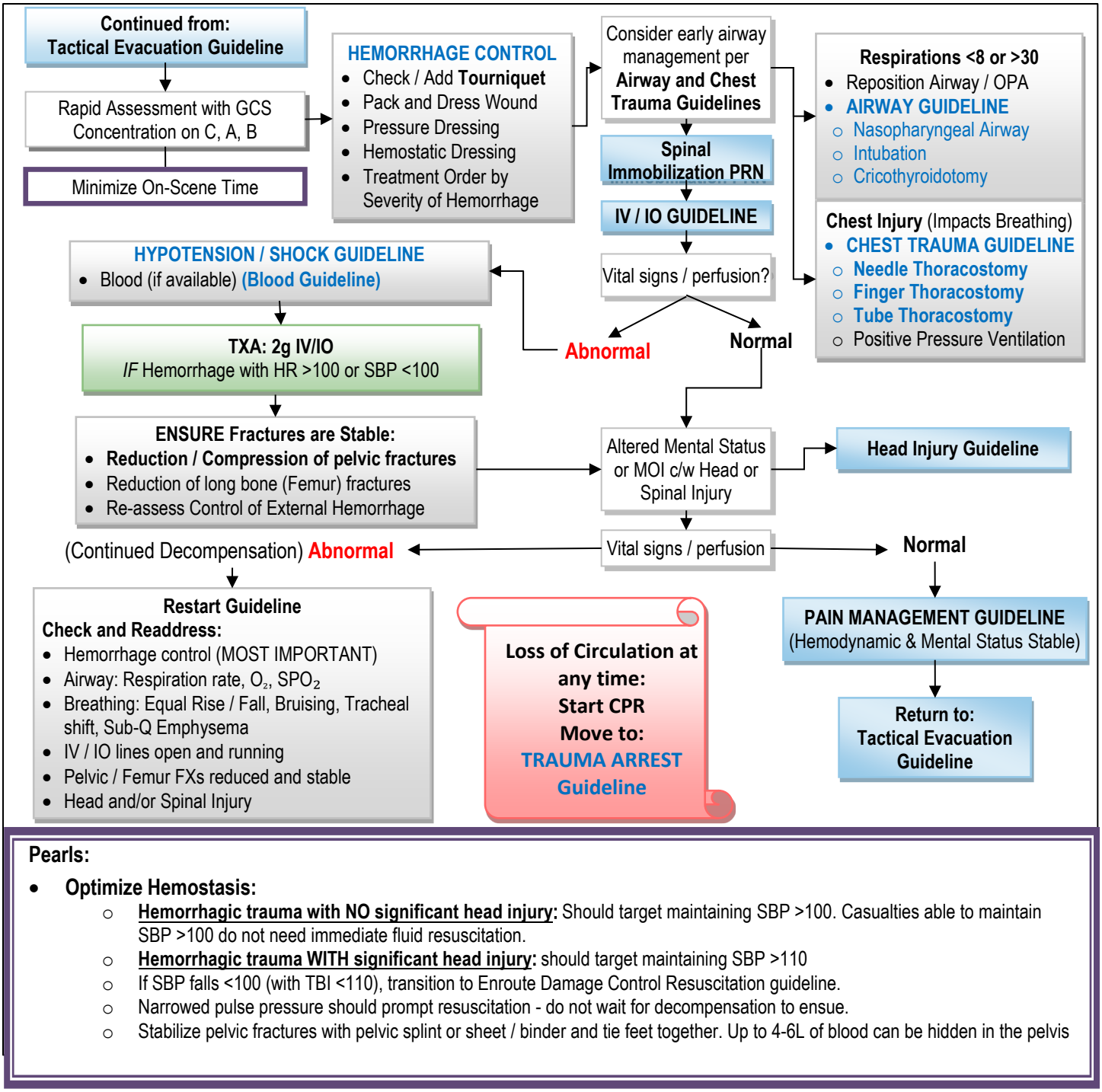
MULTIPLE TRAUMA

Signs and Symptoms:

- **Pain, Swelling, Bleeding, Ecchymosis**
- **Deformity**
- **Altered Mental Status**
- **Respiratory Distress / Failure**
- **Vomiting**
- **Hypotension / Shock**
- **Cardiac Arrest**

Possible Injuries / Diagnoses:

- **Tension Pneumothorax**
- **Flail Chest**
- **Pericardial Tamponade**
- **Open Chest Wound**
- **Hemothorax**
- **Intra-abdominal Injury / Bleeding**
- **Head Injury, HEENT injuries**
- **Extremity Fracture / Dislocation**
- **Hypothermia**
- **Burns**
- **Pelvis / Long-bone Fracture**
- **Spine / Spinal Cord Injury**


Continued from: Tactical Evacuation Guideline
Rapid Assessment with GCS Concentration on C, A, B
Minimize On-Scene Time
HEMORRHAGE CONTROL
Check / Add Tourniquet
Pack and Dress Wound
Pressure Dressing
Hemostatic Dressing
Treatment Order by Severity of Hemorrhage
Consider early airway management per Airway and Chest Trauma Guidelines
Spinal Immobilization PRN
IV / IO GUIDELINE
Vital signs / perfusion?
Abnormal
Normal
Respirations <8 or >30
Reposition Airway / OPA
AIRWAY GUIDELINE
Nasopharyngeal Airway
Intubation
Cricothyroidotomy
Chest Injury (Impacts Breathing)
CHEST TRAUMA GUIDELINE
Needle Thoracostomy
Finger Thoracostomy
Tube Thoracostomy
Positive Pressure Ventilation
HYPOTENSION / SHOCK GUIDELINE
Blood (if available) (Blood Guideline)
TXA: 2g IV/IO
IF Hemorrhage with HR >100 or SBP <100
ENSURE Fractures are Stable:
Reduction / Compression of pelvic fractures
Reduction of long bone (Femur) fractures
Re-assess Control of External Hemorrhage
Altered Mental Status or MOI c/w Head or Spinal Injury
Head Injury Guideline
Vital signs / perfusion
(Continued Decompensation) Abnormal
Normal
Restart Guideline
Check and Readdress:
Hemorrhage control (MOST IMPORTANT)
Airway: Respiration rate, O2, SPO2
Breathing: Equal Rise / Fall, Bruising, Tracheal shift, Sub-Q Emphysema
IV / IO lines open and running
Pelvic / Femur FXs reduced and stable
Head and/or Spinal Injury
Loss of Circulation at any time:
Start CPR
Move to:
TRAUMA ARREST Guideline
PAIN MANAGEMENT GUIDELINE
(Hemodynamic & Mental Status Stable)
Return to: Tactical Evacuation Guideline

Pearls:

- **Optimize Hemostasis:**
  - **Hemorrhagic trauma with NO significant head injury:** Should target maintaining SBP >100. Casualties able to maintain SBP >100 do not need immediate fluid resuscitation.
  - **Hemorrhagic trauma WITH significant head injury:** should target maintaining SBP >110
  - If SBP falls <100 (with TBI <110), transition to Enroute Damage Control Resuscitation guideline.
  - Narrowed pulse pressure should prompt resuscitation - do not wait for decompensation to ensue.
  - Stabilize pelvic fractures with pelvic splint or sheet / binder and tie feet together. Up to 4-6L of blood can be hidden in the pelvis

Pediatric MULTIPLE TRAUMA

Signs and Symptoms:

- **Pain, Swelling, Bleeding**
- **Ecchymosis**
- **Deformity**
- **Altered Mental Status**
- **Respiratory Distress / Failure**
- **Vomiting**
- **Hypotension / Shock**
- **Cardiac Arrest**

Possible Injuries / Diagnoses:

- **Tension Pneumothorax**
- **Flail Chest**
- **Pericardial Tamponade**
- **Open Chest Wound**
- **Hemothorax**
- **Intra-abdominal Injury / Bleeding**
- **Pelvis / Long-bone Fracture**
- **Spine / Spinal Cord Injury**
- **Head Injury**
- **Extremity Fracture / Dislocation**
- **HEENT Injuries**
- **Hypothermia**
- **Burns**

Continued from: Tactical Evacuation Guideline

Rapid Assessment with GCS Concentration on C, A, B

Minimize On-Scene Time

HEMORRHAGE CONTROL

- Check / Add **Tourniquet**
- Pack and Dress Wound
- Pressure Dressing
- Hemostatic Dressing
- Treatment Order by Severity of Hemorrhage

Consider early airway management per **Airway and Chest Trauma Guidelines**

Spinal Immobilization PRN

IV / IO GUIDELINE

Vital Signs / **GLUCOSE**

Abnormal **Normal**

Respirations Abnormal

- Reposition Airway / OPA
- **PEDs AIRWAY GUIDELINE**
  - Nasopharyngeal Airway
  - Intubation
  - Cricothyroidotomy

Chest Injury (Impacts Breathing)

- **CHEST TRAUMA GUIDELINE**
  - **Needle Thoracostomy**
  - **Tube Thoracostomy**
  - Positive Pressure Ventilation

TXA if: Hemorrhage with ↑HR or ↓SBP Average

Pediatric HYPOTENSION / SHOCK GUIDELINE

- WB, 1:1:1, or pRBC's (if available) (**Blood Guideline**)
- Bolus **ALL FLUIDS**
- 10mL/kg Blood Bolus in <20 min.
- 20mL/kg IVF if blood not available

ENSURE Fractures are Stable:

- **Reduction / Compression of pelvic fractures**
- Reduction of long bone (Femur) fractures
- Reassess Control of External Hemorrhage

Altered Mental Status or MOI c/w Head or Spinal Injury

Head Injury Guideline

Vital Signs / Perfusion?

(Continued Decompensation) **Abnormal**

Normal

Restart Guideline

Check and Readdress:

- Hemorrhage control
- Airway: Respiration rate, O_2, and Sats
- Breathing: Equal Rise / Fall, Bruising, Tracheal shift, Sub-Q Emphysema
- IV / IO lines open and running
- Pelvic / Femur FXs reduced and stable
- Head and/or Spinal Injury

Loss of Circulation at any time: **Start CPR**
100-120 Comp/Min

- 1 Rescuer: 30 Compressions to 2 Breaths
- 2 Rescuer: 15 Compressions to 2 Breaths

Move to: **TRAUMA ARREST Guideline**

Pediatric PAIN MANAGEMENT GUIDELINE
(Hemodynamic & Mental Status Stable)

Return to: Tactical Evacuation Guideline

Pearls:

- **Resuscitation: Maintain, SBP to at least [70 + 2 x age (yr)] or to mental status change.**
- **Normotesion: [90 + 2 x age (yr)]**
- Narrowed pulse pressure should prompt resuscitation – do not wait for decompensation to ensue.
- Stabilize pelvic fractures with Pelvic Splint or sheet / binder and tie feet together. Up to 80% of blood volume can be hidden in the pelvis.
- Follow Length Based Resuscitation Tape for Pediatric ALS Equipment.

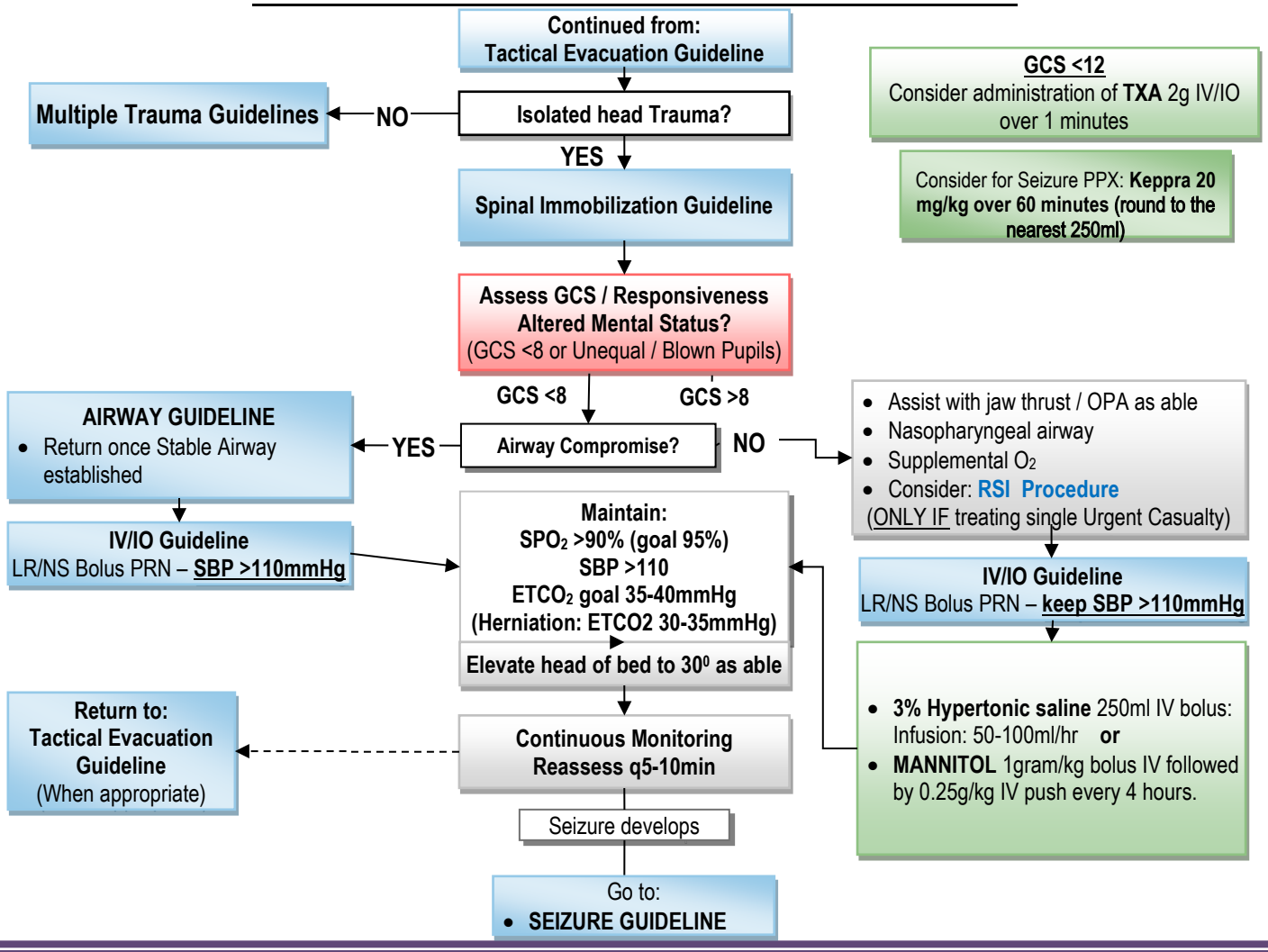
HEAD INJURY/TBI

Signs and Symptoms:

- **Pain, Swelling, Bleeding**
- **Ecchymosis**
- **Deformity**
- **Altered Mental Status**
- **Respiratory Distress / Failure**
- **Vomiting**

Differential Diagnosis:

- **Skull Fracture**
- **Brain Injury**
- **Epidural Hematoma**
- **Subdural Hematoma**
- **Subarachnoid Hemorrhage**
- **Spinal Injury**
- **Abuse**



Pearls:

Evidence of Elevated ICP and Herniation: Unilateral or Bilateral Fixed / Sluggish and blown pupils, persistent/repetitive vomiting, decorticate or decerebrate posture, motor abnormalities, Cushing's **Reflex**: (Hypertension & Bradycardia +/- Respiratory depression)

- Prevention of hypoxic insult is key! Maintain PO_2 and maintain cerebral perfusion pressure by preventing hypotension.
  - Target Vital Functions: **SBP >110mm Hg, SPO_2 >95%, $ETCO_2$ at 35-40mmHg, MAP 80-110.**
  - It is CRITICALLY IMPORTANT to avoid both hypo-capnea and hyper-capnea. Dedicated and closely managed ventilation is key to optimal patient outcome.
- With clear signs of **herniation,** may consider *temporizing* hyperventilation with 100% O_2 and capnography: **titrate CO_2 to 30-35mm Hg**.
- **Mannitol** should be given as boluses – not a constant infusion. Do not use in hypotensive, dehydration, or under-resuscitated patients
- **KETAMINE** Not an absolute contraindicated in ICP with hypertension and/or spontaneous cerebral hemorrhage.

BURNS

Signs and Symptoms:

- **Burns, Pain, Swelling**
- **Dizziness**
- **Loss of Consciousness**
- **Airway Involvement (e.g., singed nasal hair, carbonaceous sputum)**
- **Hoarseness / Wheezing**
- **Loss of Consciousness**

Differential Diagnosis:

- **Superficial Burns (1st degree)**
- **Partial Thickness (2nd degree)**
- **Full Thickness (3rd degree)**
- **Chemical Burns**
- **Thermal Burns**
- **Electrical Burns**
- **Radiation**
- **Secondary Trauma**

All TC3 interventions can be done through burnt or charred skin e.g. IV, TQ, surgical cricothyroidotomy, needle decompression. Consider escharotomy if circumferential burn to chest compromising ventilation.

>40% TBSA burn, comatose, symptomatic inhalation injury, or deep facial require large ETT (Sz 8 adult)

Universal Patient Care Guideline

↓

Remove rings, bracelets, or other constricting items

↓

Rapid exam for additional Injuries

↓

Position patient supine Immobilize area

↓

AIRWAY INVOLVEMENT?

YES → **AIRWAY Guideline** Consider: Early establishment of Advanced Airway

→ **Pediatric AIRWAY Guideline** Consider: Early establishment of Advanced Airway

→ Return to **AIRWAY INVOLVEMENT?**

NO →

THERMAL / ELECTRIC (See Pearl)

↓

Remove burning / charred clothing Cool with sterile saline / gel pad

↓

Cover with Dry sheet / dry sterile dressings

CHEMICAL (See Pearl)

↓

Brush off any dry chemical contamination

↓

Cut off contaminated clothing Flush area with saline 10-15min

↓

If Eye is involved: Flush with saline x 30min

↓

Determine / Start Fluid Replacement (BURN Fluid Resuscitation)

↓

HYPOTHERMIA PREVENTION

↓

PAIN CONTROL

↓

Place Foley Catheter (as able) Monitor Urinary Output

→ **Tactical Evacuation Guideline**

Burn Depth:

Superficial / Partial Thickness Burns:

- **1st Degree:** (limited to epidermis) Red, Hypersensitive, and Painful: Not medically significant and not calculated in Fluid Therapy
- **2nd Degree:** (epidermis and part of dermis) Very Painful, Red and Blistered, Wet, Weepy or Whiter and Edematous

Full Thickness Burns

- **3rd Degree:** (destruction throughout dermis) Non Painful, Whitish / Charred skin often with coagulate vessels (does not blanch to touch)
- **4th Degree:** (destruction through fat, fascia, muscle, and bone)

Pearl: Hydrofluoric Acid- Arterial infusion over 4 hr (40mL of D5W with 10mL of 10% calcium gluconate).
Tear Gas- rinse skin and eyes with NS.
Alkali Burns to eye- 1-2 L of NS each eye for 30 minutes.
All symptomatic electric burn patients require an ECG regardless of the potential voltage.

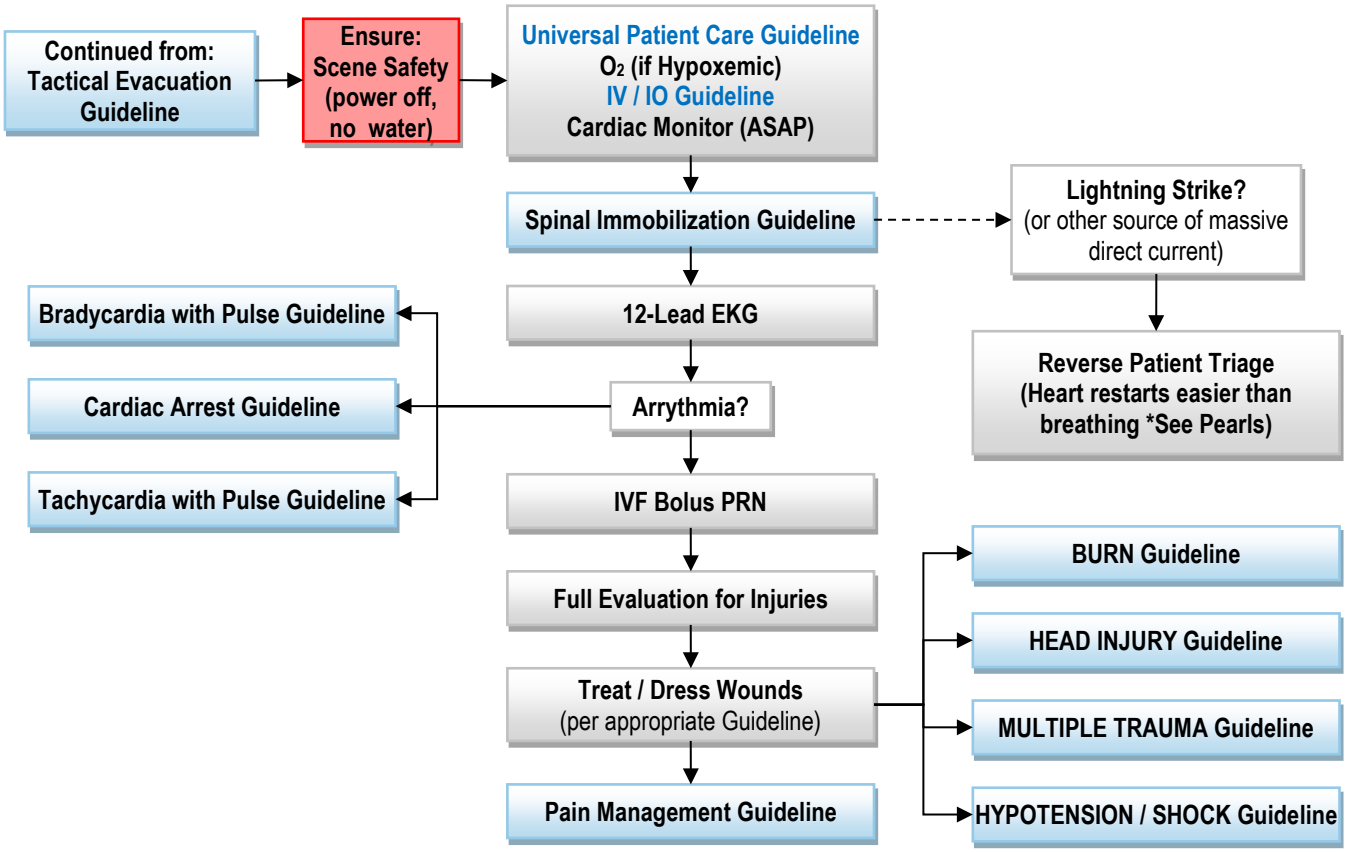
Urinary Output is the MOST Reliable Guide Predicting Adequate Resuscitation

- **Adult: 0.5ml per kg per hour (100mL/hr Electrical Burn)**
- **Children <40kg: 1ml/kg/hr**

ELECTRICAL INJURY

Signs and Symptoms:
- Burns
- Pain
- Arrhythmia
- Loss of Consciousness
- Entry / Exit Wounds
- Shock / Hypotension
- Cardiac Arrest

Differential Diagnosis:
- Cardiac Arrest
- Environmental Exposure
- Seizure
- Burns
- Multiple Trauma

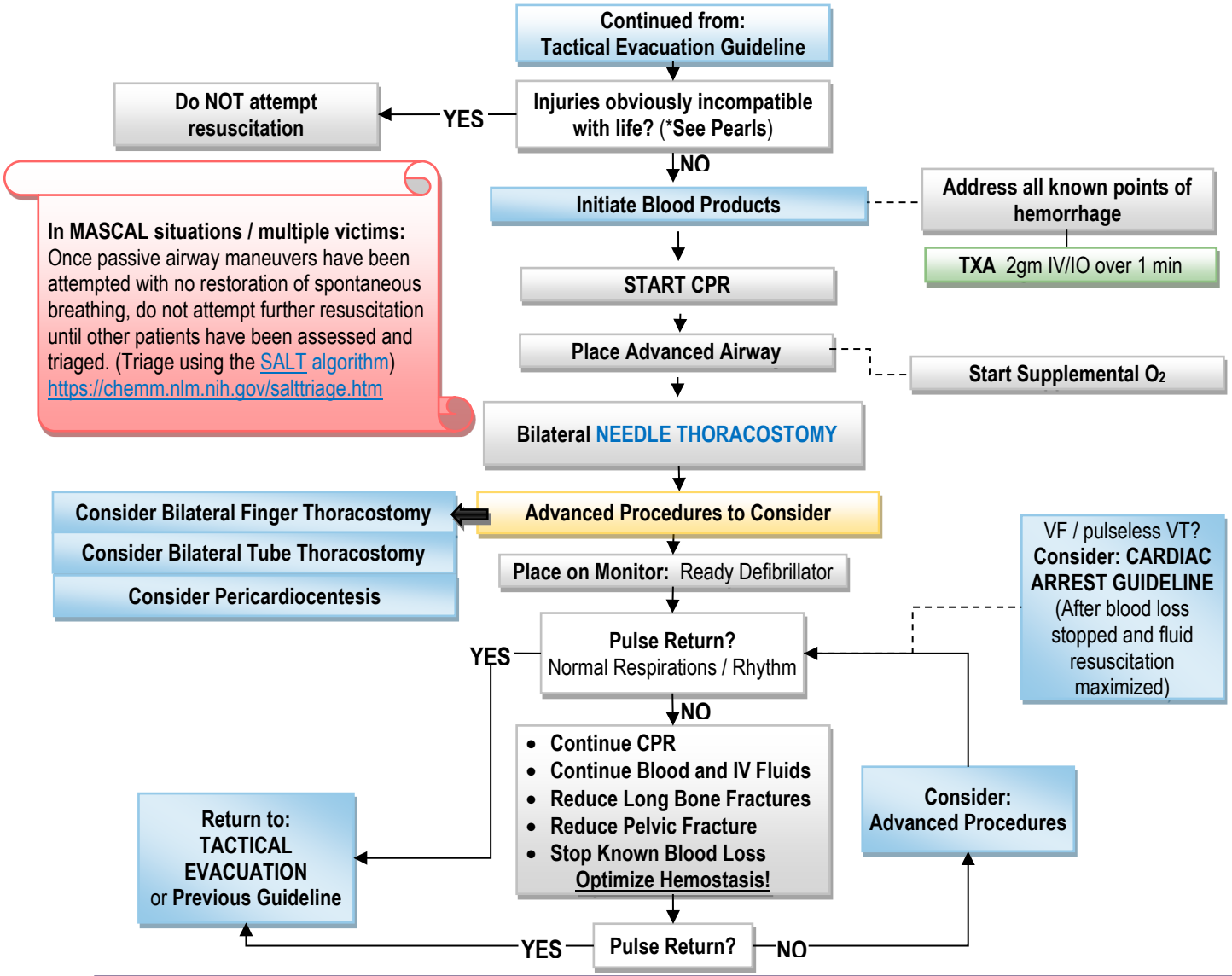

Continued from: Tactical Evacuation Guideline
Ensure: Scene Safety (power off, no water)
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)
Spinal Immobilization Guideline
Lightning Strike? (or other source of massive direct current)
Reverse Patient Triage (Heart restarts easier than breathing *See Pearls)
12-Lead EKG
Bradycardia with Pulse Guideline
Cardiac Arrest Guideline
Tachycardia with Pulse Guideline
Arrythmia?
IVF Bolus PRN
Full Evaluation for Injuries
Treat / Dress Wounds (per appropriate Guideline)
Pain Management Guideline
BURN Guideline
HEAD INJURY Guideline
MULTIPLE TRAUMA Guideline
HYPOTENSION / SHOCK Guideline

Pearls:
- **Ventricular fibrillation (in AC) and asystole (in DC) are the most common dysrhythmias seen with electrical shock.**
- Damage is often hidden deep as current follows conductive structures (e.g., blood vessels, nerves, muscle).
- **In mass casualty situations where lightning is involved – reverse triage should be performed. <u>Those victims in full arrest should be resuscitated first.</u> The reason for this is the respiratory center of the brain takes longer to recover from the shock than the heart and respiratory support during this period can lead to survival.**
  - Specifically, if there are no spontaneous respirations after airway maneuver, but no other signs of non-survivable injury, administer ventilatory support aggressively as personnel resources allow.
- Do not overlook secondary trauma.
- Electrical shock victims do not "store" electricity and are safe to handle if current is off.
- Many electrical injury patients will also have significant burn injuries – do not overlook fluid resuscitation.

TRAUMATIC ARREST

Signs and Symptoms:
- **Evidence of Trauma with No Pulse**
- **Lack of Response to External Stimuli**

Differential Diagnosis:
- **Medical Cause of Arrest Preceding Trauma***
- **Tension Pneumothorax**
- **Hypovolemia**
- **Cardiac Tamponade**


Continued from: Tactical Evacuation Guideline
Injuries obviously incompatible with life? (*See Pearls)
YES
Do NOT attempt resuscitation
NO
Initiate Blood Products
Address all known points of hemorrhage
TXA 2gm IV/IO over 1 min
START CPR
Place Advanced Airway
Start Supplemental O2
Bilateral NEEDLE THORACOSTOMY
Advanced Procedures to Consider
Consider Bilateral Finger Thoracostomy
Consider Bilateral Tube Thoracostomy
Consider Pericardiocentesis
Place on Monitor: Ready Defibrillator
Pulse Return?
Normal Respirations / Rhythm
YES
NO
VF / pulseless VT?
Consider: CARDIAC ARREST GUIDELINE
(After blood loss stopped and fluid resuscitation maximized)
Continue CPR
Continue Blood and IV Fluids
Reduce Long Bone Fractures
Reduce Pelvic Fracture
Stop Known Blood Loss
Optimize Hemostasis!
Consider: Advanced Procedures
Return to: TACTICAL EVACUATION or Previous Guideline
Pulse Return?
YES
NO
In MASCAL situations / multiple victims:
Once passive airway maneuvers have been attempted with no restoration of spontaneous breathing, do not attempt further resuscitation until other patients have been assessed and triaged. (Triage using the SALT algorithm)
https://chemm.nlm.nih.gov/salttriage.htm

Pearls:
- **Injuries obviously incompatible with life** include decapitation, massively deforming head / chest injury, traumatic hemi-corpectomy or total body disruption, incineration, lividity/rigor mortis.
- If unsure if arrest due to trauma or medical cause, initiate ALS guideline for any arrhythmias following optimization of hemostasis (in trauma patients, volume loss must be corrected 1st, consider blood admin above all else)
- CPR without addressing massive hemorrhage, blood volume resuscitation, tension pneumothorax, and pericardial tamponade will be ineffective..
- *Consider severe hypocalcemia if blood products have recently been transfused due to calcium chelation and evidence of poor cardiac activity/contractility.

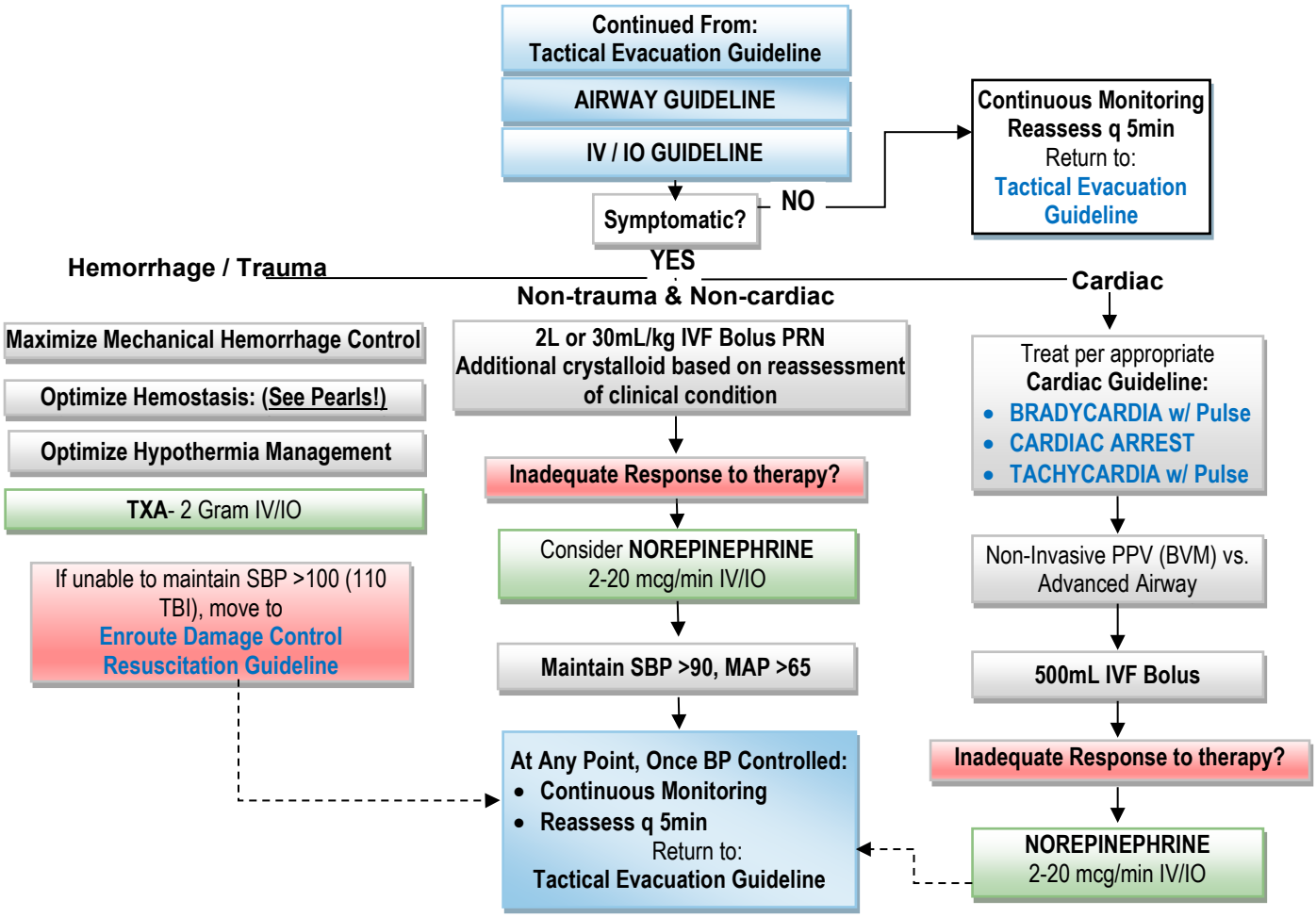
HYPOTENSION / SHOCK

Signs and Symptoms:

- Restlessness / Confusion
- Weakness / Dizziness
- Tachycardia
- Pale, Cool, Clammy Skin
- Delayed Capillary Refill
- Hypotension
- Bleeding
- Nausea / Vomiting

Differential Diagnosis:

- Shock: Hypovolemic, Cardiogenic, Septic, Neurogenic, Anaphylactic
- Cardiac Arrhythmia
- Pulmonary Embolus
- Tension Pneumothorax
- Medication Effect / OD
- Vasovagal Episode

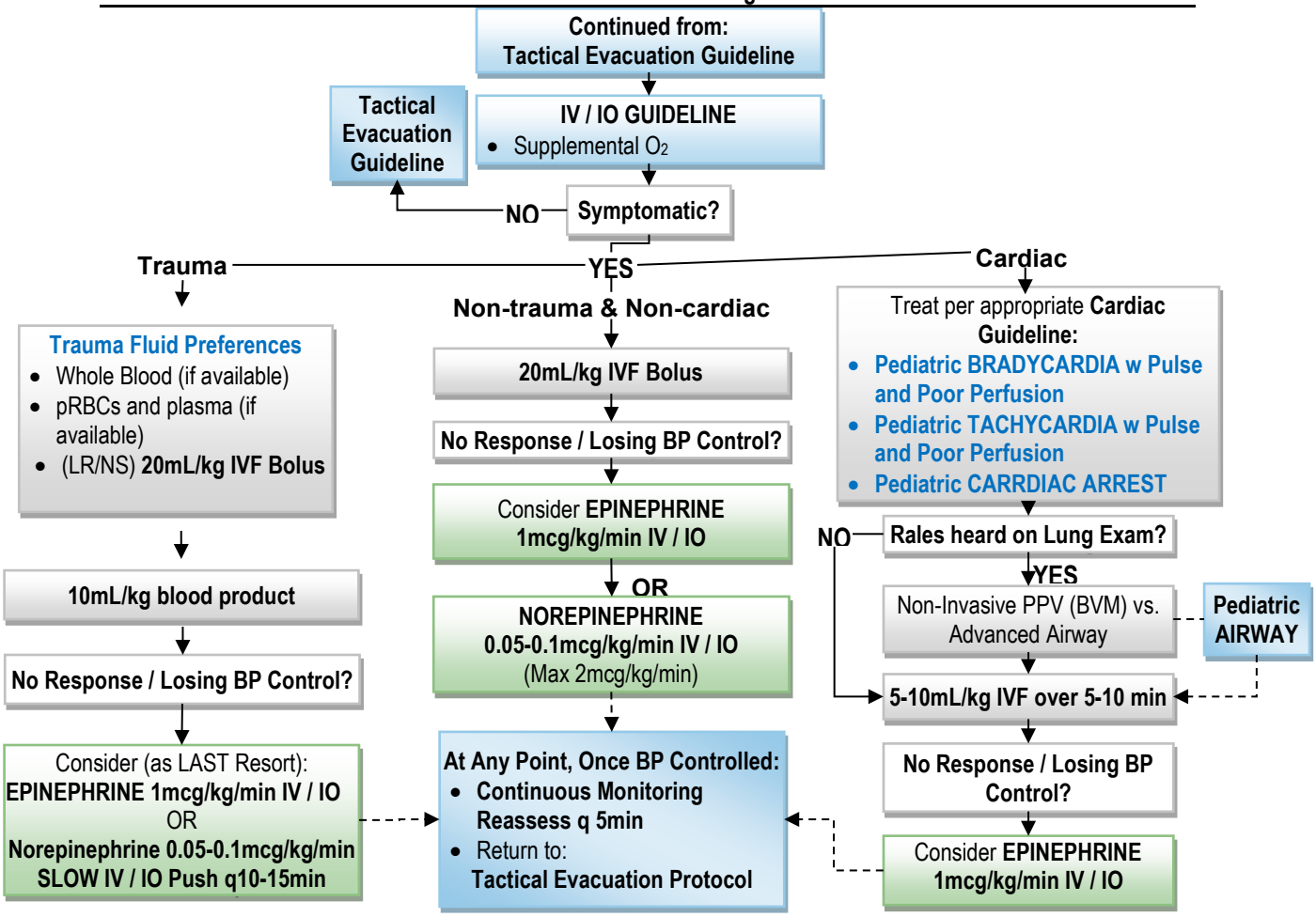


Pearls:

- **Optimize Hemostasis:**
  - **Hemorrhagic trauma with NO significant head injury:** Should target maintaining SBP >100. Casualties able to maintain SBP >100 do not need immediate fluid resuscitation.
  - **Hemorrhagic trauma WITH significant head injury:** should target maintaining SBP >110
  - If SBP falls <100 (with TBI <110), transition to Enroute Damage Control Resuscitation guideline.

Pediatric HYPOTENSION / SHOCK

Signs and Symptoms:	Differential Diagnosis:
• Restlessness / Confusion • Weakness / Dizziness • Tachycardia • Pale, Cool, Clammy Skin • Delayed Capillary Refill • Hypotension • Nausea / Vomiting • Responsiveness / Lethargy	• Shock: Hypovolemic, Cardiogenic, Septic, Neurogenic, Anaphylactic • Cardiac Arrhythmia • Pulmonary Embolus • Tension Pneumothorax • Medication Effect / OD • Vasovagal Episode • Dehydration • Congenital Heart Disease



Pearls:

- **Hypotension in pediatric patients is defined as a SBP less than 70 + [2 x age (yr)].**
- Decreasing heart rate with worsening neuro or clinical exam may be a sign of impending collapse in pediatric patients
- Consider all the causes of shock and treat per appropriate protocol.
- Avoid Pressors as able (unless distributive or cardiogenic shock) Continue IVFs for trauma: Optimize hemostasis and correct volume loss.

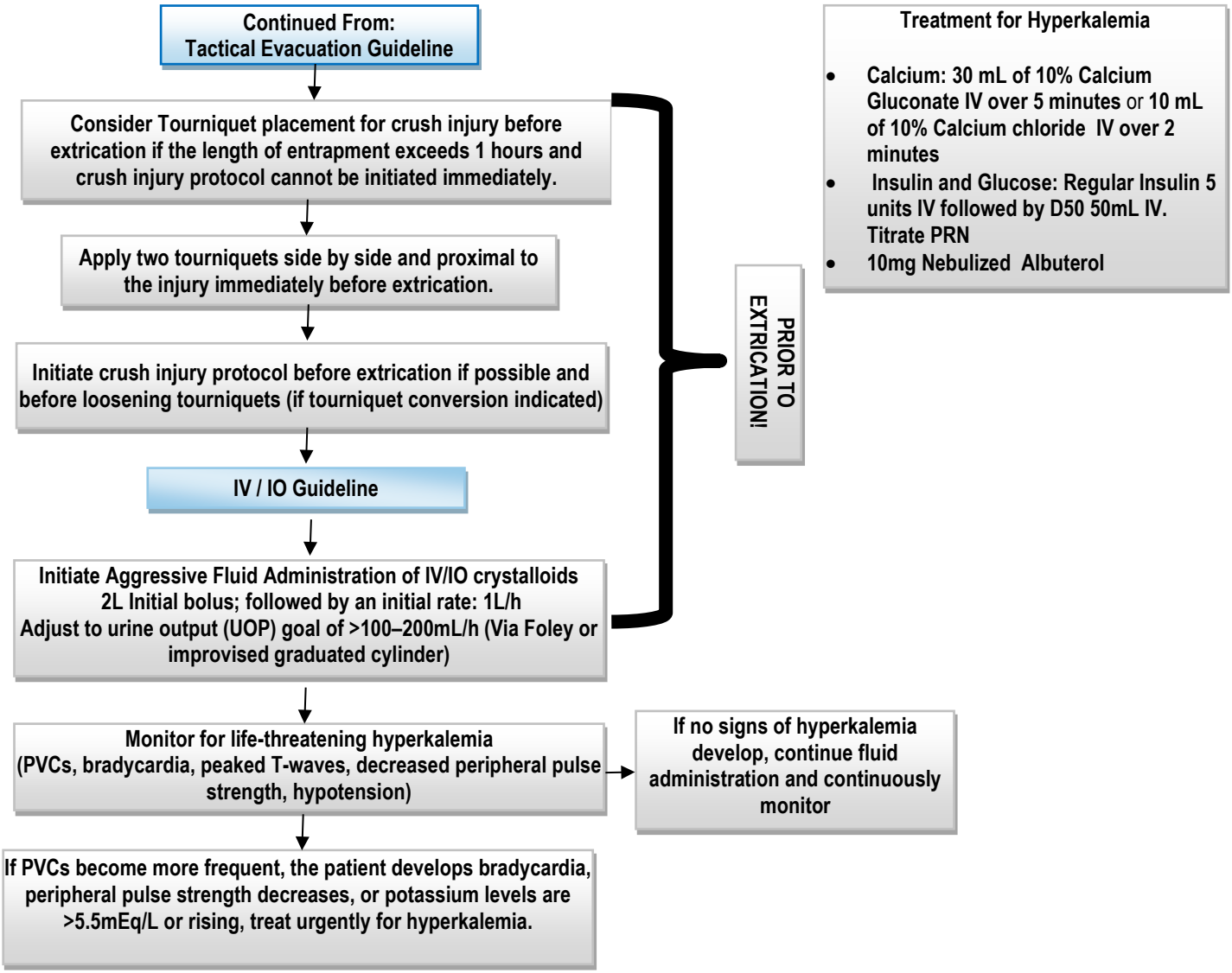
CRUSH SYNDROME

Signs and Symptoms:

- Entrapped extremity (as little as 1hr)
- Erythema, ecchymosis, abrasion
- Swelling, tense muscle compartment

Complications:

- Hyperkalemia
- Hypocalcemia
- Compartment Syndrome
- Rhabdomyolysis
- Arrhythmia
- Hypotension


Continued From:
Tactical Evacuation Guideline
Consider Tourniquet placement for crush injury before extrication if the length of entrapment exceeds 1 hours and crush injury protocol cannot be initiated immediately.
Apply two tourniquets side by side and proximal to the injury immediately before extrication.
Initiate crush injury protocol before extrication if possible and before loosening tourniquets (if tourniquet conversion indicated)
IV / IO Guideline
Initiate Aggressive Fluid Administration of IV/IO crystalloids
2L Initial bolus; followed by an initial rate: 1L/h
Adjust to urine output (UOP) goal of >100–200mL/h (Via Foley or improvised graduated cylinder)
Monitor for life-threatening hyperkalemia
(PVCs, bradycardia, peaked T-waves, decreased peripheral pulse strength, hypotension)
If PVCs become more frequent, the patient develops bradycardia, peripheral pulse strength decreases, or potassium levels are >5.5mEq/L or rising, treat urgently for hyperkalemia.
If no signs of hyperkalemia develop, continue fluid administration and continuously monitor
PRIOR TO EXTRICATION!
Treatment for Hyperkalemia
Calcium: 30 mL of 10% Calcium Gluconate IV over 5 minutes or 10 mL of 10% Calcium chloride IV over 2 minutes
Insulin and Glucose: Regular Insulin 5 units IV followed by D50 50mL IV. Titrate PRN
10mg Nebulized Albuterol

Pearls:

- Crush syndrome can occur in as little as 1 hour of entrapment
- Tourniquets may delay life-threatening complications if fluid resuscitation and treatment cannot be immediately initiated
- Aggressive fluid resuscitation for Crush injury in the setting of noncompressible hemorrhage may increase hemorrhage. Balance the risk of uncontrolled hemorrhage against cardiotoxic effects of hyperkalemia.

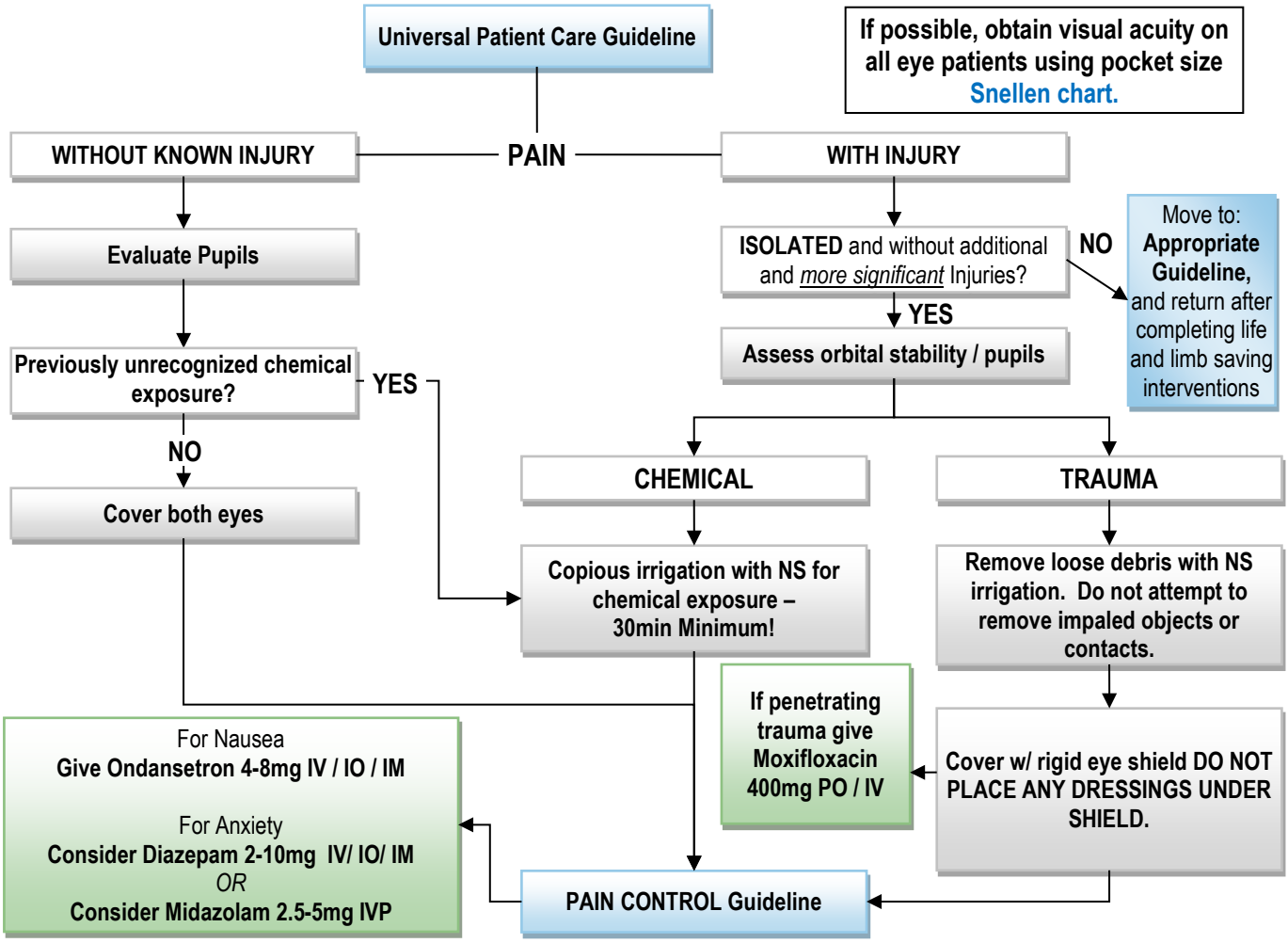
EYE INJURY / PAIN

Signs and Symptoms:

- **Pain, Swelling, Blood**
- **Decreased Visual Acuity / Blindness**
- **Deformity / Contusion**
- **Foreign Body**
- **Excessive Tearing**

Differential Diagnosis:

- **Abrasion / Laceration**
- **Globe Rupture / Orbital fracture**
- **Retinal Detachment**
- **Chemical / Thermal Burn**
- **Infection / Iritis**
- **CNS Event**
- **Glaucoma**
- **Retinal Vessel Occlusion**


Universal Patient Care Guideline
If possible, obtain visual acuity on all eye patients using pocket size Snellen chart.
PAIN
WITHOUT KNOWN INJURY
WITH INJURY
Evaluate Pupils
ISOLATED and without additional and more significant Injuries?
NO
Move to: Appropriate Guideline, and return after completing life and limb saving interventions
YES
Assess orbital stability / pupils
Previously unrecognized chemical exposure?
YES
NO
Cover both eyes
CHEMICAL
TRAUMA
Copious irrigation with NS for chemical exposure – 30min Minimum!
Remove loose debris with NS irrigation. Do not attempt to remove impaled objects or contacts.
If penetrating trauma give Moxifloxacin 400mg PO / IV
Cover w/ rigid eye shield DO NOT PLACE ANY DRESSINGS UNDER SHIELD.
For Nausea
Give Ondansetron 4-8mg IV / IO / IM
For Anxiety
Consider Diazepam 2-10mg IV/ IO/ IM
OR
Consider Midazolam 2.5-5mg IVP
PAIN CONTROL Guideline

Pearls:

- Antiemetics are essential to prevent increased IOP. Consider Benzo for anxiety.
- Use rigid eye shields, not pads, for traumatic injuries. Can use a soft pad on unaffected eye.
- Patching both eyes to decrease sympathetic eye movements has not been shown to improve visual outcome but may increase anxiety and will render patient unable to move independently.
- If globe is out of socket – do not attempt to replace. Cover with saline soaked gauze
- Copious irrigation is the cornerstone of treatment for chemical eye injuries. 30 min is the minimum amount of time to irrigate. Utilize Morgan lens if available.
    - The use of a nasal cannula across the bridge of the nose attached to 1L of NS will also work.

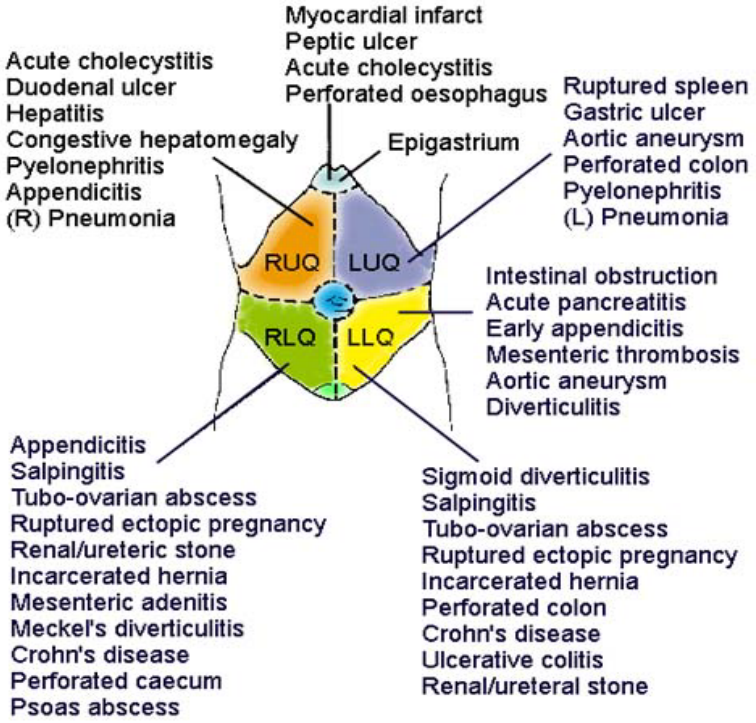
ABDOMINAL PAIN

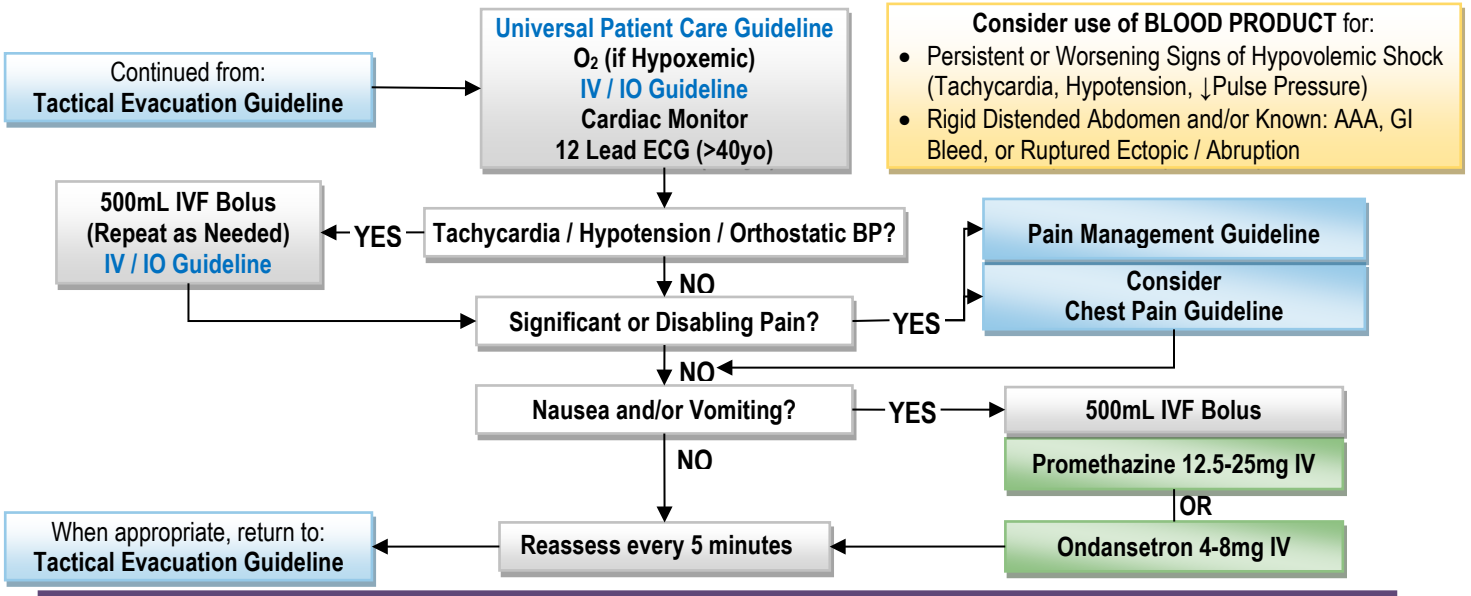
Signs and Symptoms:

- **Pain (RUQ, RLQ, LUQ, LLQ) (Location / Migration / Radiation)**
- **Tenderness**
- **Nausea / Vomiting**
- **Diarrhea (Bloody?)**
- **Dysuria**
- **Constipation**
- **Vaginal Bleeding / Discharge**
- **Distention**
- **Guarding / Rigidity**

Associated symptoms:

- **Fever, Headache, Weakness, Malaise / Fatigue, Myalgia, Cough, Mental Status Changes, Rash**





Pearls:

- Maintain a high index of suspicion for ectopic pregnancy as a cause of abdominal pain in females of childbearing age.
- Antacids should be avoided in patients with renal disease.
- Patients older than 50 are at increased risk for life-threatening diagnoses (e.g., AAA).
- Appendicitis presents with vague, periumbilical pain that migrates to the RLQ. This classic presentation may not be present in some patients.
- Repeat VS after each intervention. In non-traumatized patients, may repeat fluid bolus PRN depending on patient condition and VS. In trauma patients, fluid boluses should be used in accordance with hypotensive resuscitation guidelines (see Multiple Trauma Guideline).
- Choose the lower promethazine dosage for patients likely to experience sedative effects (e.g., elderly).

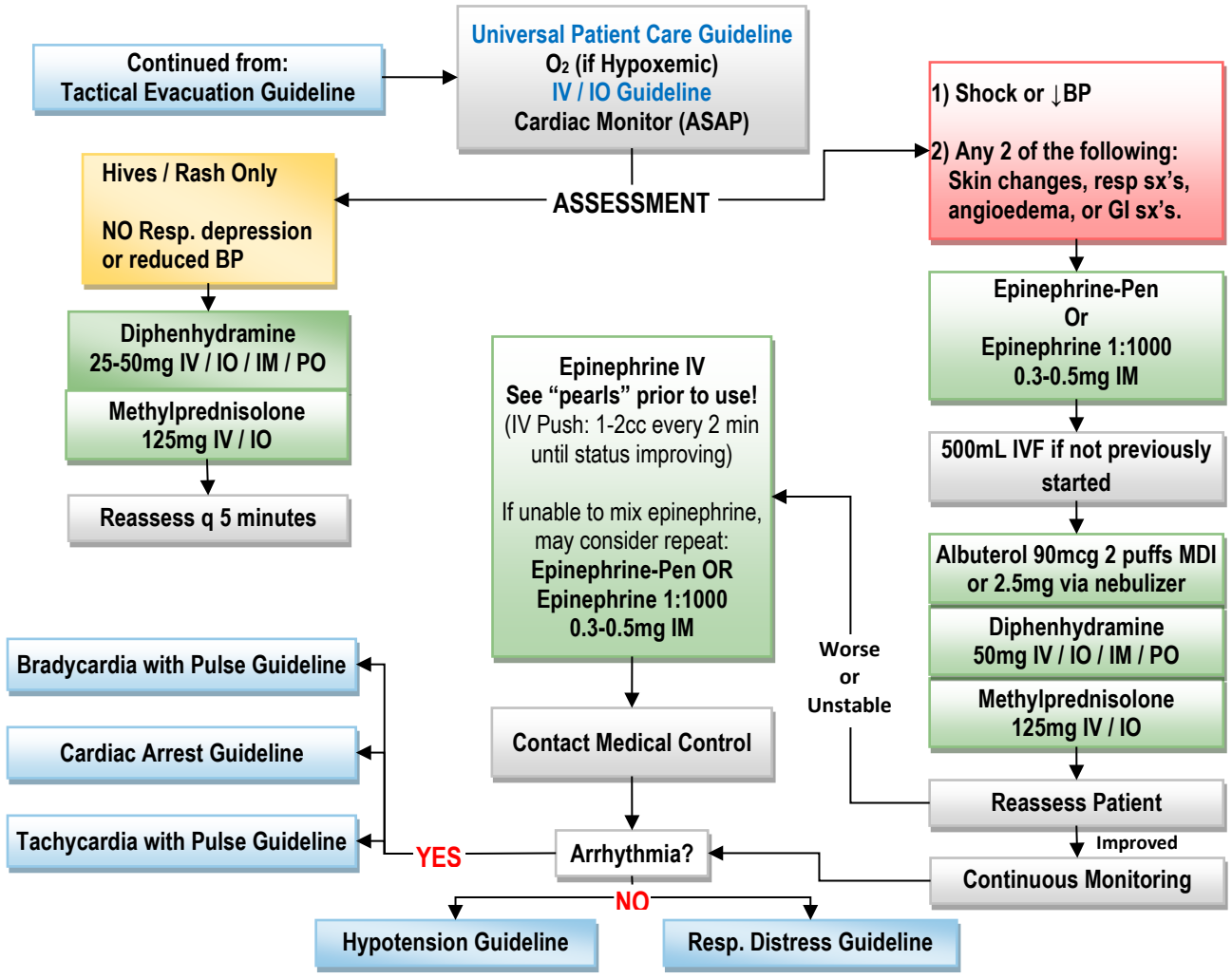
ALLERGIC REACTION

Signs and Symptoms:

- Itching or Hives
- Cough / Wheeze / Resp. Distress
- Chest / Throat Tightness
- Difficulty Swallowing
- Hypotension or Shock
- Edema
- Nausea / Vomiting

Differential Diagnosis:

- Urticaria (rash only)
- Shock (other than anaphylactic)
- Angioedema
- Aspiration / Airway Obstruction
- Asthma or COPD
- Pulmonary Edema / CHF

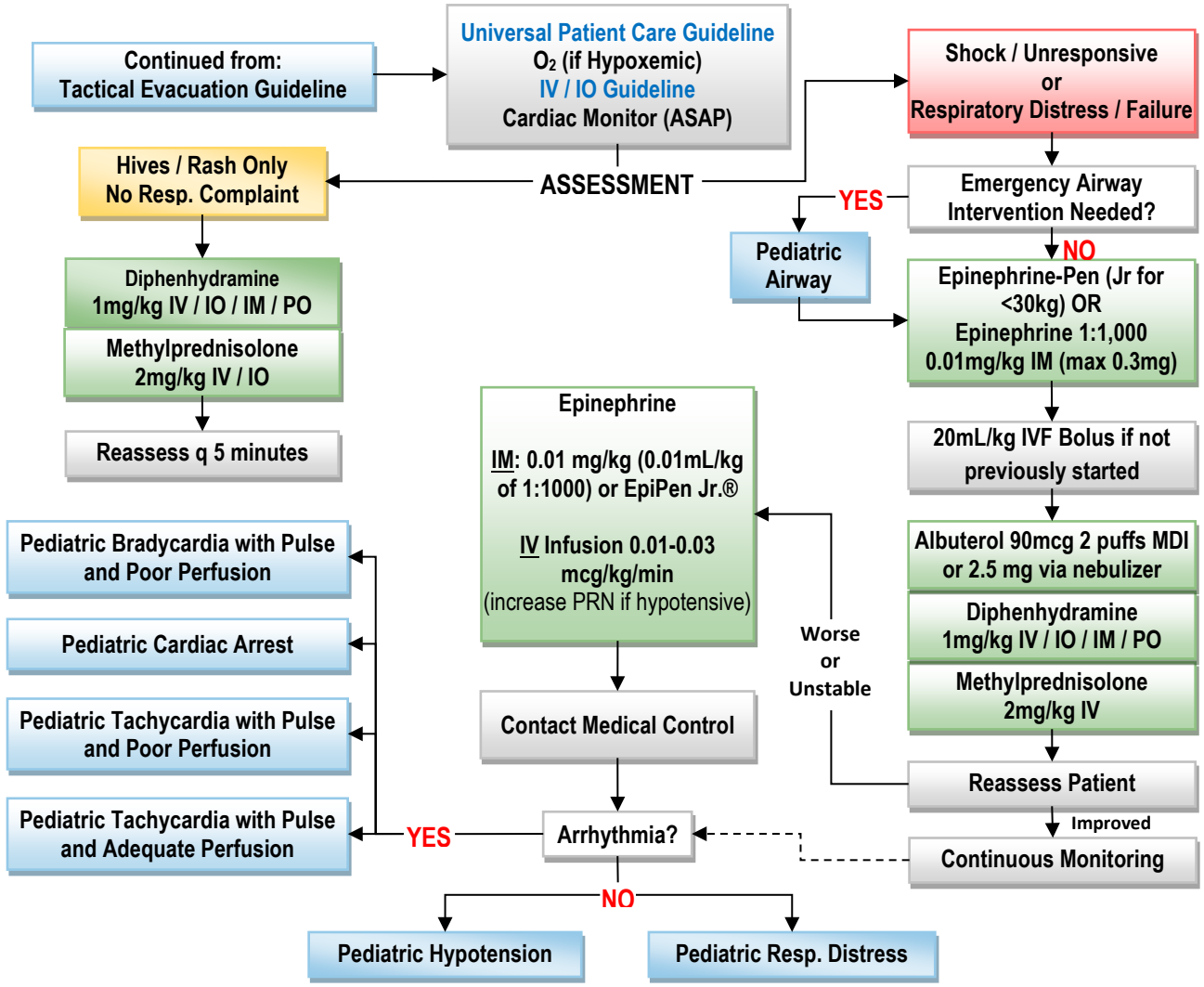

Continued from: Tactical Evacuation Guideline
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)
ASSESSMENT
Hives / Rash Only
NO Resp. depression or reduced BP
Diphenhydramine 25-50mg IV / IO / IM / PO
Methylprednisolone 125mg IV / IO
Reassess q 5 minutes
1) Shock or ↓BP
2) Any 2 of the following: Skin changes, resp sx's, angioedema, or GI sx's.
Epinephrine-Pen Or Epinephrine 1:1000 0.3-0.5mg IM
500mL IVF if not previously started
Albuterol 90mcg 2 puffs MDI or 2.5mg via nebulizer
Diphenhydramine 50mg IV / IO / IM / PO
Methylprednisolone 125mg IV / IO
Reassess Patient
Improved
Continuous Monitoring
Epinephrine IV
See "pearls" prior to use!
(IV Push: 1-2cc every 2 min until status improving)
If unable to mix epinephrine, may consider repeat:
Epinephrine-Pen OR
Epinephrine 1:1000
0.3-0.5mg IM
Worse or Unstable
Contact Medical Control
Arrhythmia?
YES
NO
Bradycardia with Pulse Guideline
Cardiac Arrest Guideline
Tachycardia with Pulse Guideline
Hypotension Guideline
Resp. Distress Guideline

Pearls:

- Use caution prior to giving epinephrine IV to patients >50yo, pregnant, have a history of cardiac disease, or have HR >150. Epinephrine can precipitate dysrhythmias / ischemia – all patients should be on monitors and have 12-lead ECG.
- **Epinephrine**:
  - IM: 0.3-0.5mg (0.3-0.5 mL 1:1000) or EpiPen®
  - IV Bolus: 100 mcg over 5-10 min; mix 0.1mg (0.1 mL of 1:1000 in 10mL NS, and infuse over 5-10 min)
  - IV Infusion: Start at 1 mcg/min; mix 1mg (1 mL of 1:1000 in 500 mL NS, and infuse at 0.5 mL/min; titrate as needed
- The shorter the interval from contact to symptoms, the more severe the reaction.

Pediatric ALLERGIC REACTION

Signs and Symptoms:	Differential Diagnosis:
• Itching or Hives	• Urticaria (rash only)
• Cough / Wheeze / Resp. Distress	• Anaphylaxis (2 or more systems)
• Chest/Throat tightness	• Shock (other than anaphylactic)
• Difficulty Swallowing	• Angioedema
• Hypotension or Shock	• Aspiration / Airway Obstruction
• Edema	• Asthma or COPD
• Nausea / Vomiting	• Pulmonary Edema / CHF


Continued from: Tactical Evacuation Guideline
Universal Patient Care Guideline
O_2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)
Shock / Unresponsive or Respiratory Distress / Failure
Hives / Rash Only No Resp. Complaint
ASSESSMENT
YES
Emergency Airway Intervention Needed?
Pediatric Airway
NO
Diphenhydramine 1mg/kg IV / IO / IM / PO
Methylprednisolone 2mg/kg IV / IO
Reassess q 5 minutes
Epinephrine-Pen (Jr for <30kg) OR Epinephrine 1:1,000 0.01mg/kg IM (max 0.3mg)
20mL/kg IVF Bolus if not previously started
Albuterol 90mcg 2 puffs MDI or 2.5 mg via nebulizer
Diphenhydramine 1mg/kg IV / IO / IM / PO
Methylprednisolone 2mg/kg IV
Reassess Patient
Improved
Continuous Monitoring
Epinephrine
IM: 0.01 mg/kg (0.01mL/kg of 1:1000) or EpiPen Jr.®
IV Infusion 0.01-0.03 mcg/kg/min
(increase PRN if hypotensive)
Worse or Unstable
Contact Medical Control
Arrhythmia?
YES
NO
Pediatric Bradycardia with Pulse and Poor Perfusion
Pediatric Cardiac Arrest
Pediatric Tachycardia with Pulse and Poor Perfusion
Pediatric Tachycardia with Pulse and Adequate Perfusion
Pediatric Hypotension
Pediatric Resp. Distress

Pearls:

- Epinephrine can precipitate dysrhythmias / ischemia – all patients should be on monitors and have 12-lead ECG.
- The shorter the interval from contact to symptoms, the more severe the reaction.

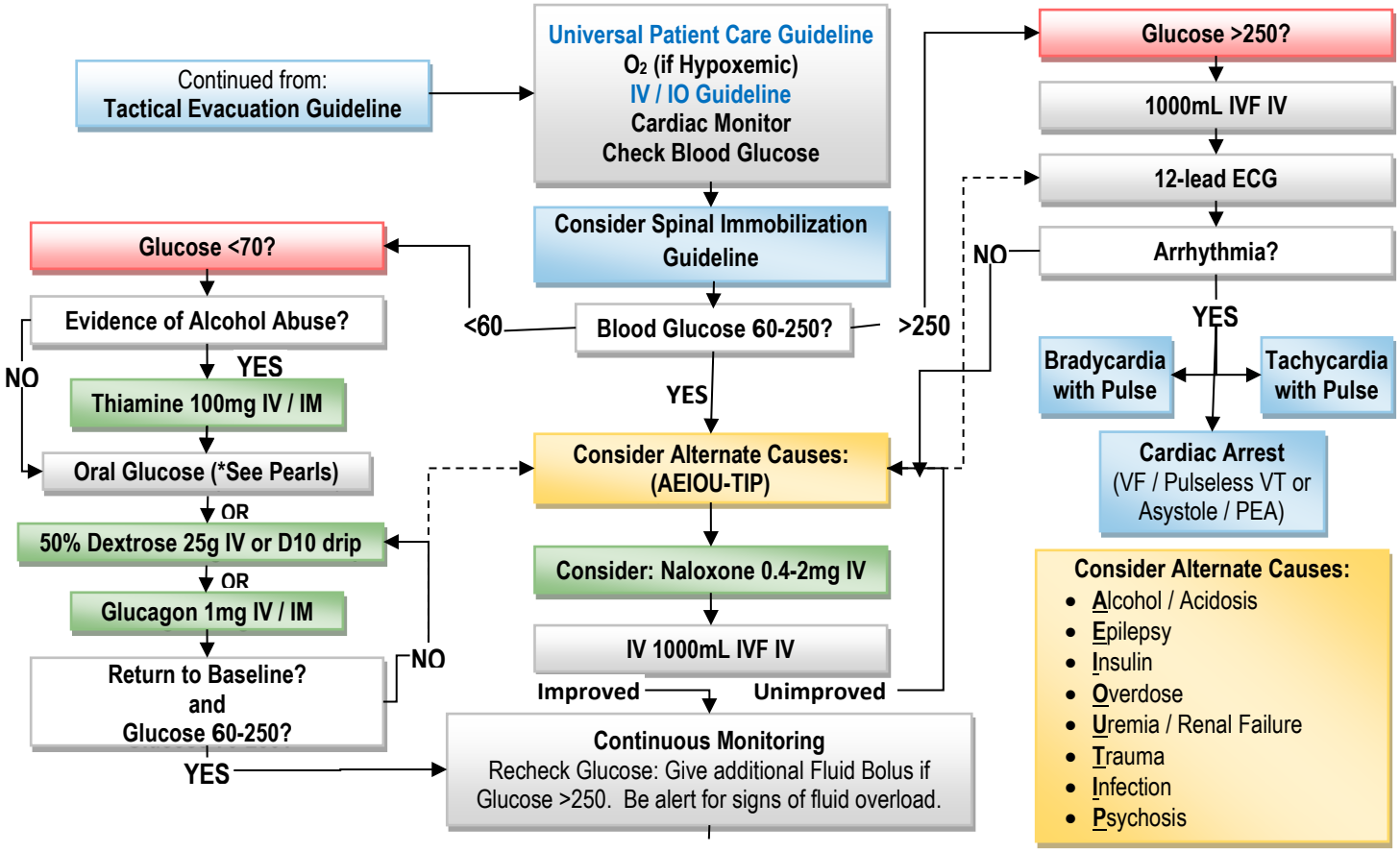
ALTERED MENTAL STATUS

Signs and Symptoms:

- Decreased Mental Status / Coma
- Bizarre Behavior
- Somnolence
- Diaphoresis / Dry, Red Skin
- Polyuria / Polydipsia
- Sweet / Fruity Breath
- Altered Respirations
- Signs of Trauma
- Fever

Differential Diagnosis:

- Head Trauma
- Stroke
- CNS Tumor / Mass / Bleed / Infection
- Thyroid Dysfunction
- Hyperglycemia / Hypoglycemia
- Diabetic Ketoacidosis
- Toxic Exposure
- Environment (Hyperthermia / Hypothermia)
- Hypoxia
- Psychiatric Disorders
- Seizure Disorder
- Sepsis



Pearls:

- Be aware of AMS as a presentation of environmental exposure / toxins / hazmat – use personal protection accordingly / decontamination.
- **Recheck blood glucose after each intervention**.
- ***Oral glucose okay if patient alert, protecting airway, and solution available**. Proteins + complex carbs (e.g., sandwich, granola) are better, longer lasting glucose source than simple sugars.
- EKG should be obtained in all suspected toxin or diabetic ketoacidosis cases – evaluate for tall, peaked T-waves (hyperkalemia) or QRS widening >100ms (toxins).
- Restrain patient as necessary for their safety and crewmembers safety during flight.
- Glucagon may cause nausea / vomiting – should have anti-emetic prepared.

Pediatric AMS

Signs and Symptoms:

- Decreased Mental Status / Coma
- Bizarre Behavior
- Somnolence
- Diaphoresis / Dry, Red Skin
- Polyuria / Polydipsia
- Sweet / Fruity Breath
- Altered Respirations
- Signs of Trauma
- Fever

Differential Diagnosis:

- Head Trauma
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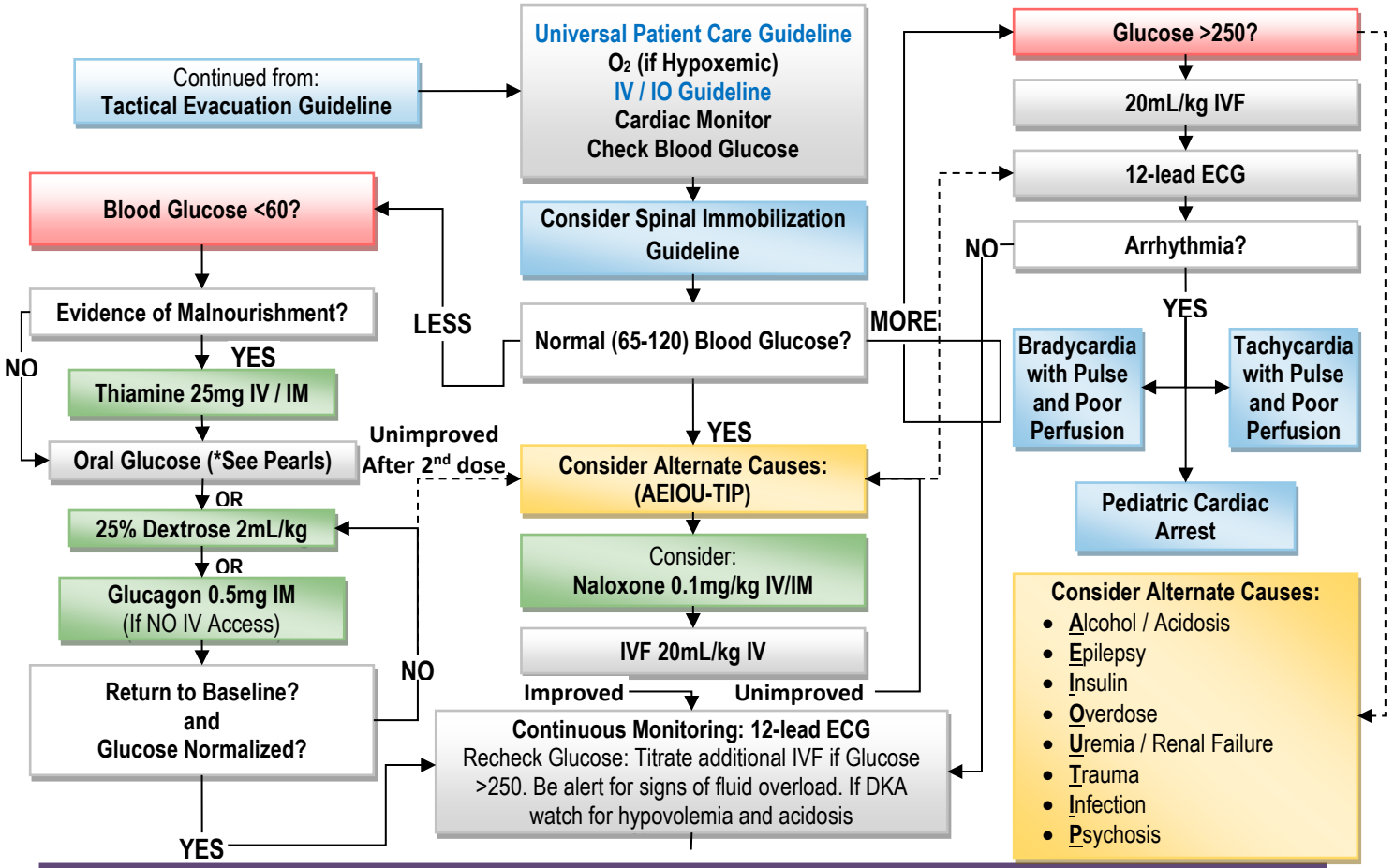
- Thyroid Dysfunction
- Hyperglycemia / Hypoglycemia
- Diabetic Ketoacidosis
- Toxic Ingestion
- Environment (Hyperthermia / Hypothermia)
- Hypoxia
- Psychiatric Disorders
- Seizure Disorder
- Sepsis



Pearls:

- Be aware of Altered Mental Status (AMS) as a presentation of environmental exposure / toxins / hazmat – use personal protection accordingly / decontamination.
- **Recheck blood glucose after each intervention**.
- ***Oral glucose okay if patient alert, protecting airway, and solution available**. Proteins + complex carbs (e.g., sandwich, granola) are better, longer lasting glucose source than simple sugars.
- EKG should be obtained in all suspected toxin or diabetic ketoacidosis cases – evaluate for tall, peaked T-waves (hyperkalemia) or QRS widening >100ms (toxins).
- Glucagon may cause nausea / vomiting – should have anti-emetic prepared.

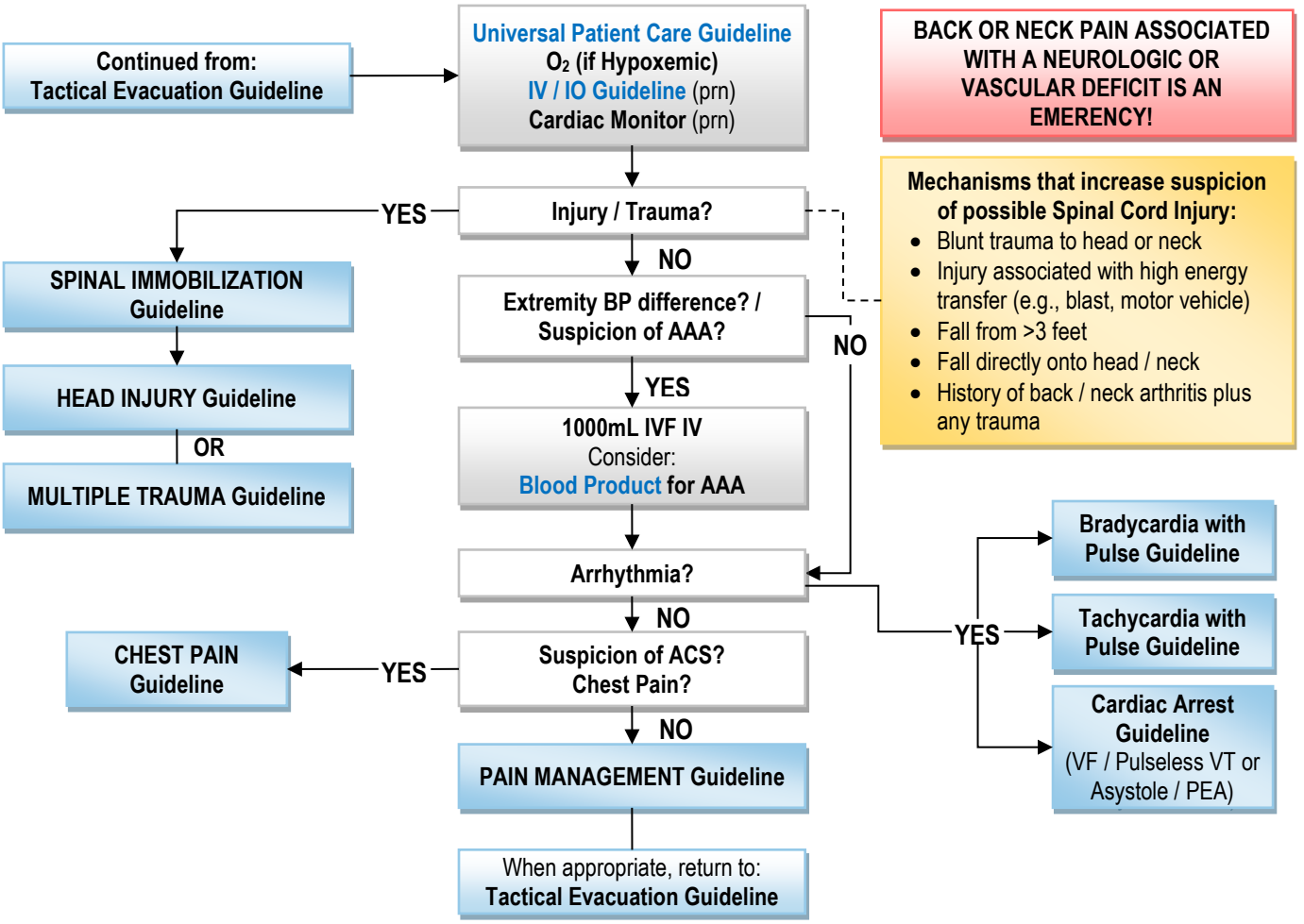
BACK and NECK PAIN

Signs and Symptoms:

- **Pain**
- **Swelling**
- **Pain with Motion**
- **Weakness / Numbness**
- **Bowel / Bladder Dysfunction**

Differential Diagnosis:

- **Muscle Spasm / Strain**
- **Degenerative Disc Disease**
- **Fracture**
- **Kidney Stone / Infection**
- **Abdominal Aortic Aneurysm**
- **Pneumonia / PE**
- **Cauda Equina Syndrome**
- **Tumor / Mass / Infection**
- ***Thoracic Pain:*** **Thoracic or abdominal aortic aneurysm**

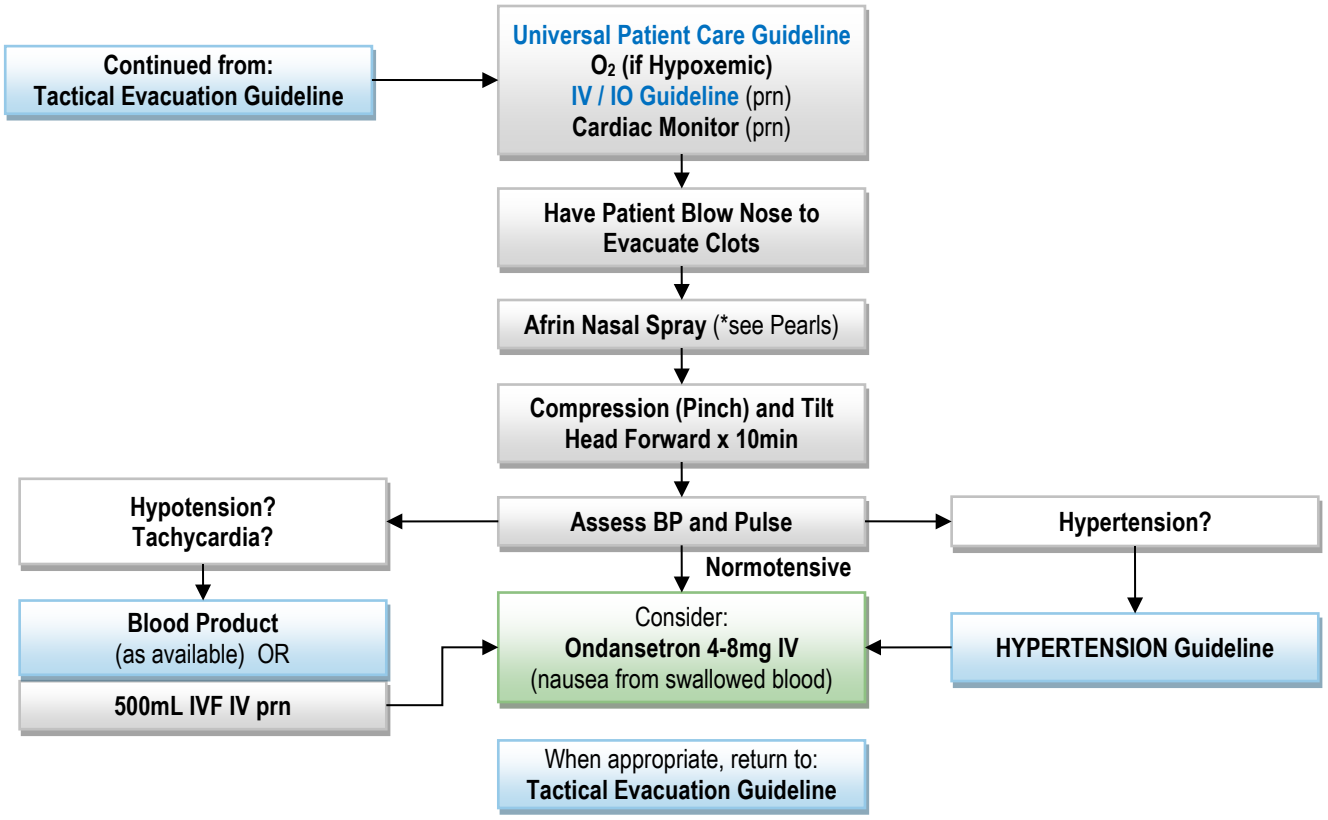


Pearls:

- Examine: mental status, HEENT, neck, chest, lungs, abdomen, back, extremities, neurologic.
- Abdominal aortic aneurysm is a concern in hypertensive / diabetic / >50yo populations – feel for pulsatile abdominal mass. Symptoms may mimic kidney stones.
- Patients with trauma / midline tenderness should be immobilized.
- Any bowel / bladder incontinence is significant and may represent a true surgical emergency (**Cauda Equina Syndrome**).

EPISTAXIS

Signs and Symptoms:	Differential Diagnosis:
• **Bleeding From One or Both Nares** • **Pain** • **Nausea / Vomiting** • **Nasal Deformity**	• **Trauma** • **Infection** • **Allergic / Chemical Rhinitis** • **Nose Picking** • **Lesions (Polyp, Ulcer)** • **Hypertension** • **Anticoagulant Therapy** • **Thrombocytopenia (ITP)**



Pearls:

- ***Avoid Afrin in patients who have a diastolic blood pressure >110** or known coronary artery disease.
- It is better to overestimate the amount of blood lost with epistaxis.
- Anticoagulants including aspirin, ibuprofen, and even herbals (ginseng) can lead to increased bleeding.
- Firm pressure should be applied for compression. Pressure should not be applied over the bridge of the nose, but instead under the bony portion to effectively compress vessels. Do not release pressure prior to the 10 minutes mark to check bleeding.
- Hypertensive patients will often not stop bleeding until BP is controlled.
- Re-bleeding is common with epistaxis.

FEVER

Signs and Symptoms:

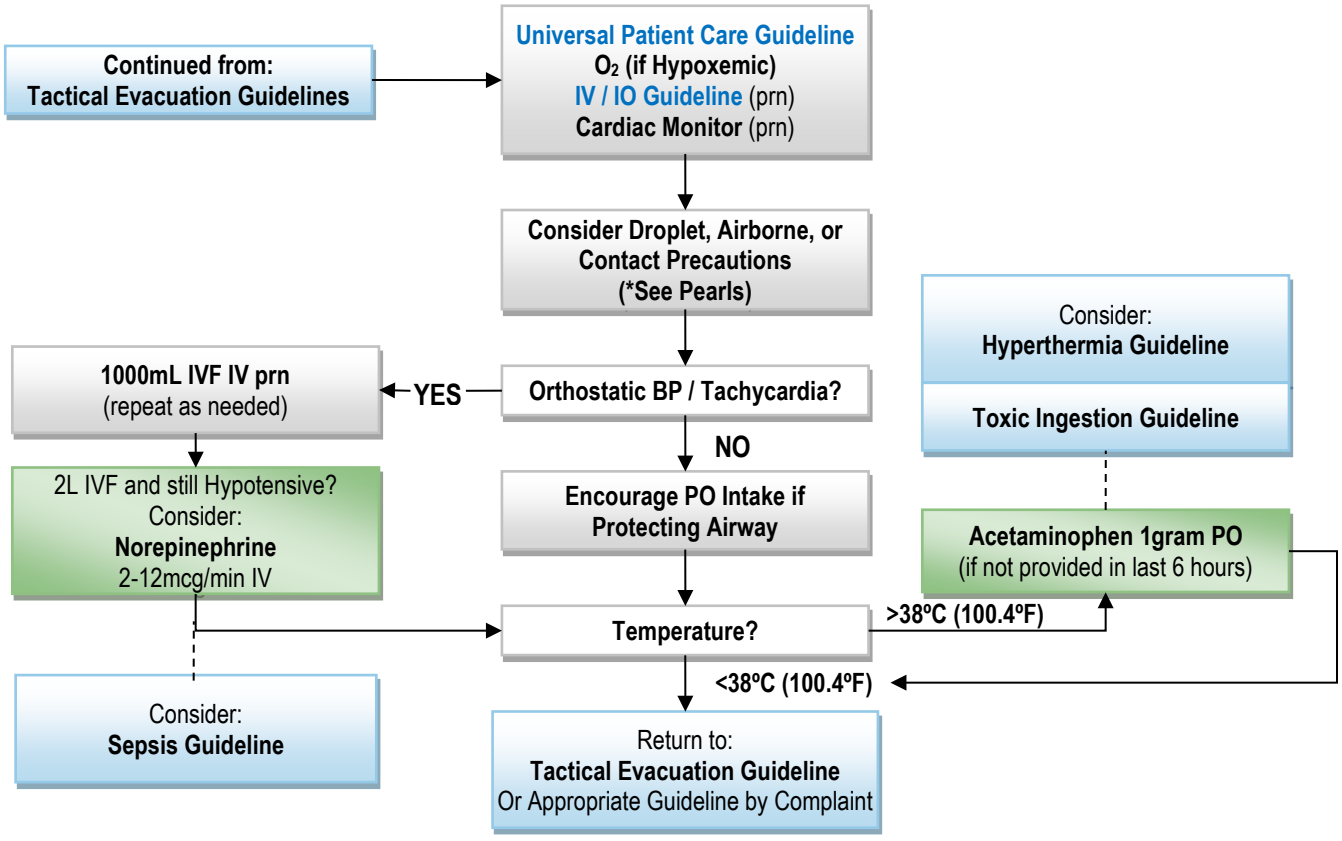
- **Warm**
- **Flushed**
- **Diaphoretic**
- **Chills**

Associated Symptoms:

- **Myalgias, Cough, Chest Pain, Headache, Dysuria, Abdominal Pain, Mental Status Change, Rash, Stiff Neck**

Differential Diagnosis:

- **Infection / Sepsis**
- **Cancer / Tumor / Lymphoma**
- **Medication / Drug Reaction**
- **Connective Tissue Diseases**
- **Hyperthyroidism**
- **Heat Stroke**
- **Meningitis**

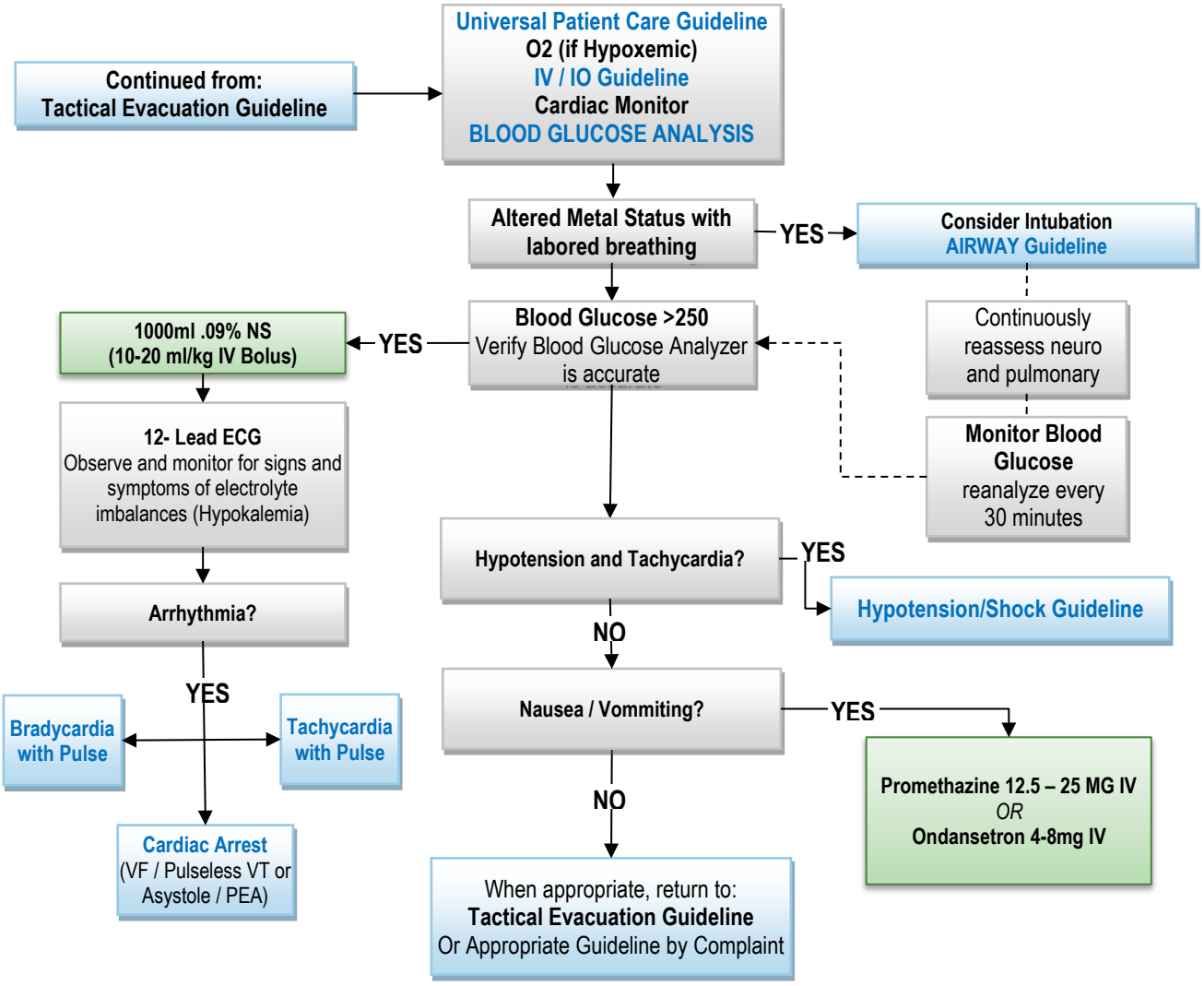

Continued from:
Tactical Evacuation Guidelines
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline (prn)
Cardiac Monitor (prn)
Consider Droplet, Airborne, or Contact Precautions (*See Pearls)
Orthostatic BP / Tachycardia?
YES
1000mL IVF IV prn (repeat as needed)
2L IVF and still Hypotensive? Consider: Norepinephrine 2-12mcg/min IV
Consider: Sepsis Guideline
NO
Encourage PO Intake if Protecting Airway
Temperature?
>38ºC (100.4ºF)
<38ºC (100.4ºF)
Consider: Hyperthermia Guideline
Toxic Ingestion Guideline
Acetaminophen 1gram PO (if not provided in last 6 hours)
Return to: Tactical Evacuation Guideline Or Appropriate Guideline by Complaint

Pearls:

- Fever may not be present in immunocompromised, elderly, or those on immunosuppressive drugs.
- All fever is not due to infection – evaluate for environmental / thyroid / toxic etiology.
- *Appropriate precautions should be used for personal protection when transporting patients with contagious disease:
  - Airborne: standard PPE plus N-95 mask and NRB or surgical mask on patient. Used for tuberculosis, measles, varicella, or other infections spread by droplets.
  - Droplet: standard surgical mask for provider and patient. Use with: influenza, meningitis, mumps, streptococcal pharyngitis.
  - Contact: standard PPE with strict hand-washing. (MRSA, scabies, varicella-zoster)
- It is better to use more PPE than is necessary.
- Acetaminophen may also be given PR if suppository form available and patient not tolerant of PO medications.

HYPERGLYCEMIA

Signs and Symptoms:	Differential Diagnosis:
• Polyuria • Polydipsia • Weakness, fatigue • Nausea, vomiting • Change in LOC • Hypotension • Tachycardia • Seizures, coma • Fruity Breath Odor	• DKA (Ketoacidosis) • Hyperosmolar Hyperglycemic Syndrome (HHS) • Head Trauma • Stroke • Hypo/Hyperthermia • Toxic Exposure

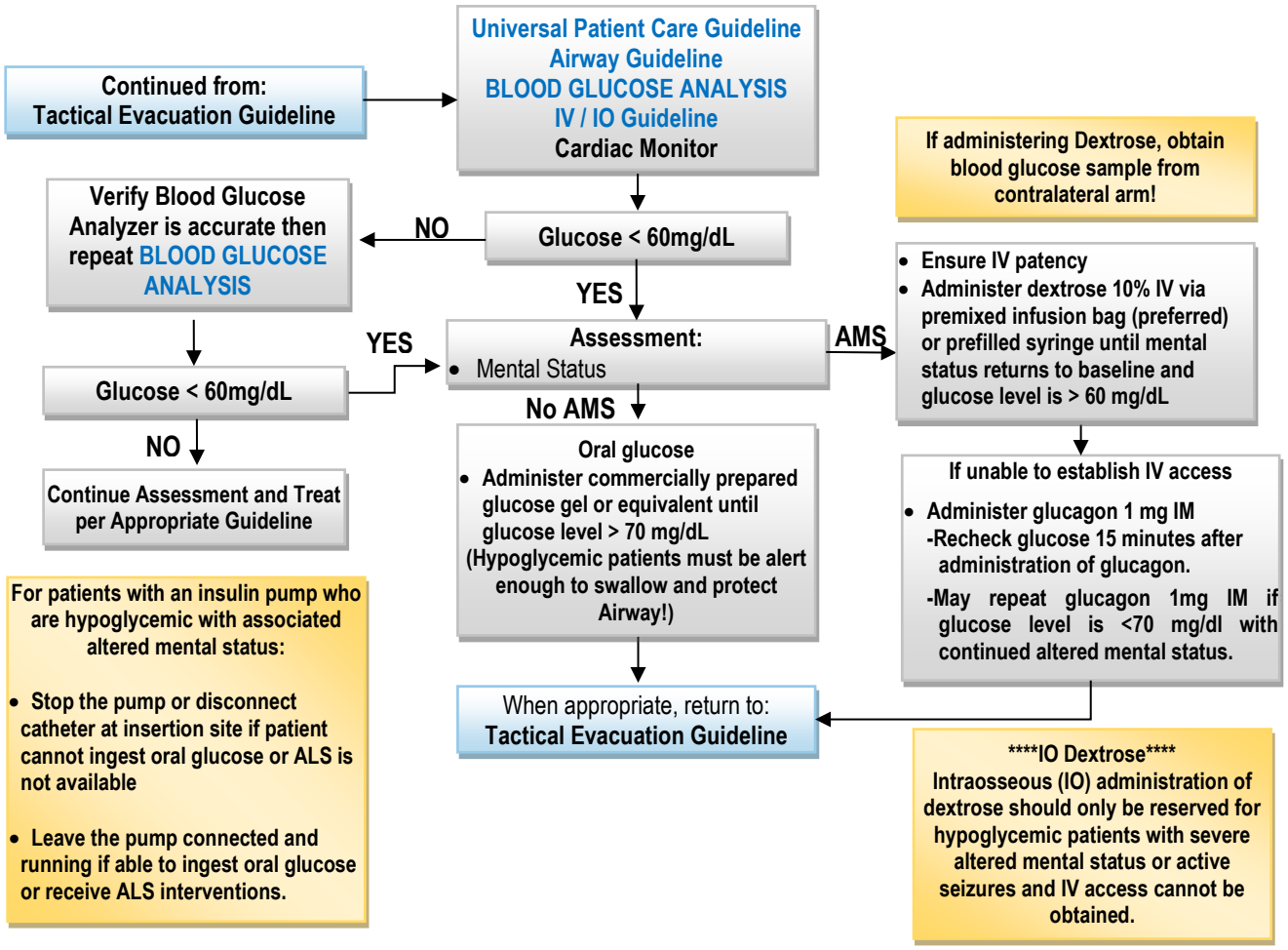


Pearls:

- If insulin is available, treat with low dose infusion, 0.1 units/kg/h
- Too rapid drop in blood glucose can cause hypoglycemia.
- Rapid drop in blood glucose levels can lead to shifts extracellular osmolality which can lead to cerebral edema
- The most common electrolyte imbalance is hypokalemia.
- Identify and treat underlying cause (infection, trauma)

HYPOGLYCEMIA

Signs and Symptoms:	Differential Diagnosis:
• Diaphoresis and pallor • Neuroglycopenic manifestations/ AMS • Tremor • Palpitations • Anxiety	• Environmental Exposure • Postprandial syndrome • CNS Dysfunction • Toxic Ingestion • Metabolic disorders



Pearls:

- There are no statistically significant differences in the median recovery time to a GCS score of 15 following administration of D10% versus D50%. D10% may benefit patients by decreasing the likelihood of post-treatment hyperglycemia and reducing the likelihood of extravasation injury.
- Sulfonylureas (e.g., glyburide, glipizide) have long half-lives ranging from 12 – 60 hours. Patients with corrected hypoglycemia who are taking these agents are at particular risk for recurrent symptoms and frequently require hospital admission.
- Hypoglycemia may be detrimental to patients at risk for cerebral ischemia, such as victims of stroke, cardiac arrest, and head trauma.
- Oral glucose equivalents include 3 - 4 glucose tablets, 4 oz. fruit juice (e.g. orange juice), non-diet soda, 1 tablespoon of pure maple syrup, sugar, or honey. Oral glucose okay if patient alert, protecting airway, and solution available. Proteins + complex carbs (e.g., sandwich, granola) are better, longer lasting glucose source than simple sugars.

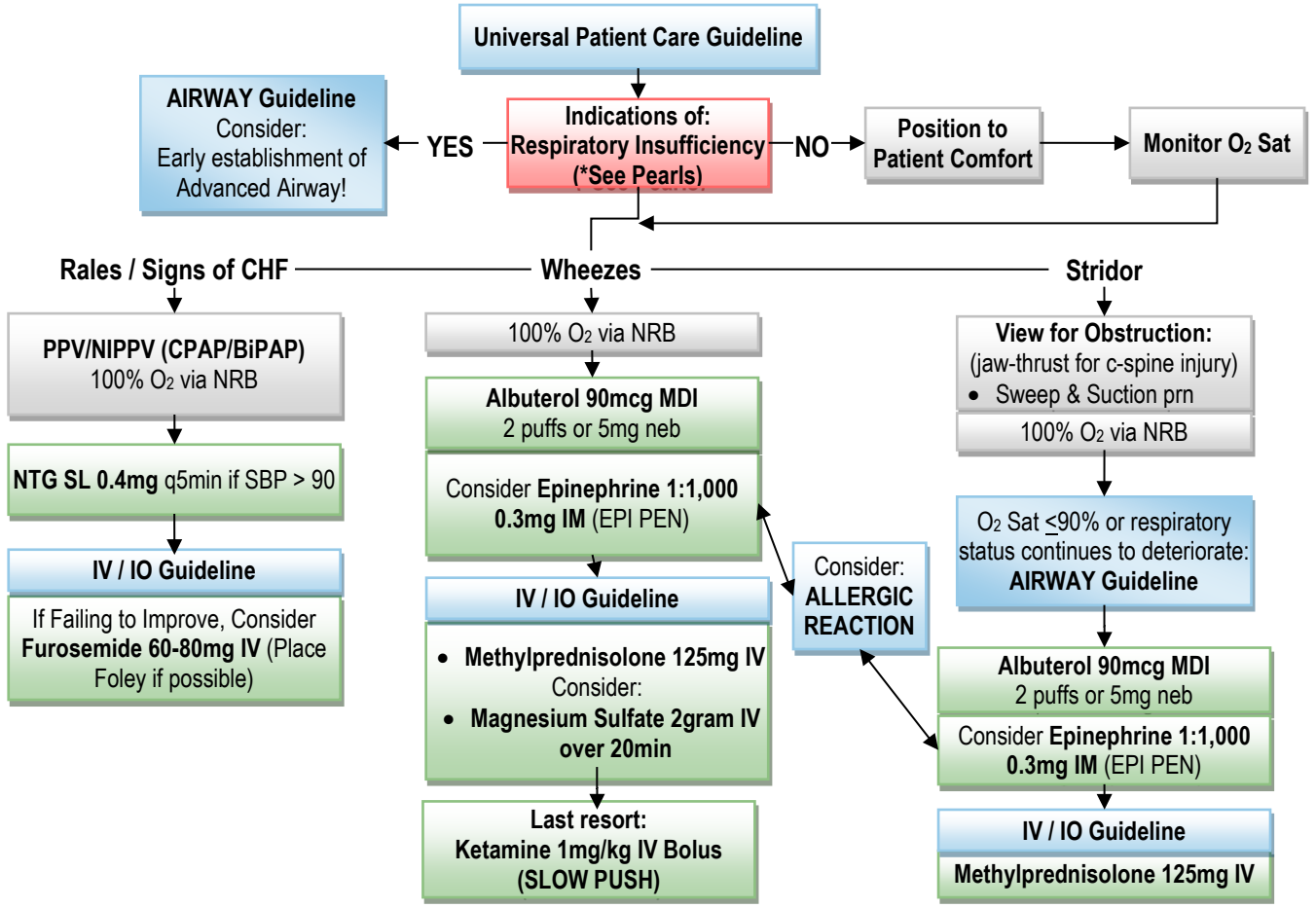
RESPIRATORY DISTRESS

Signs and Symptoms:

- **Shortness of Breath**
- **Pursed Lip Breathing**
- **Decreased Ability to Speak**
- **Tachypnea / Hyperpnea**
- **Wheezing / Rhonchi / Rales**
- **Use Accessory Muscles**
- **Fever / Cough**
- **Tachycardia**
- **Absent Breath Sounds (Emergent)**

Differential Diagnosis:

- **Asthma**
- **Anaphylaxis / Allergy**
- **Aspiration**
- **COPD**
- **Pleural Effusion**
- **Pneumonia**
- **Congestive Heart Failure / Cardiac**
- **Pulmonary Embolus**
- **Pneumothorax**
- **Pericardial Tamponade**
- **Hyperventilation**
- **Toxic Inhalation** (e.g., Cyanide, CO)

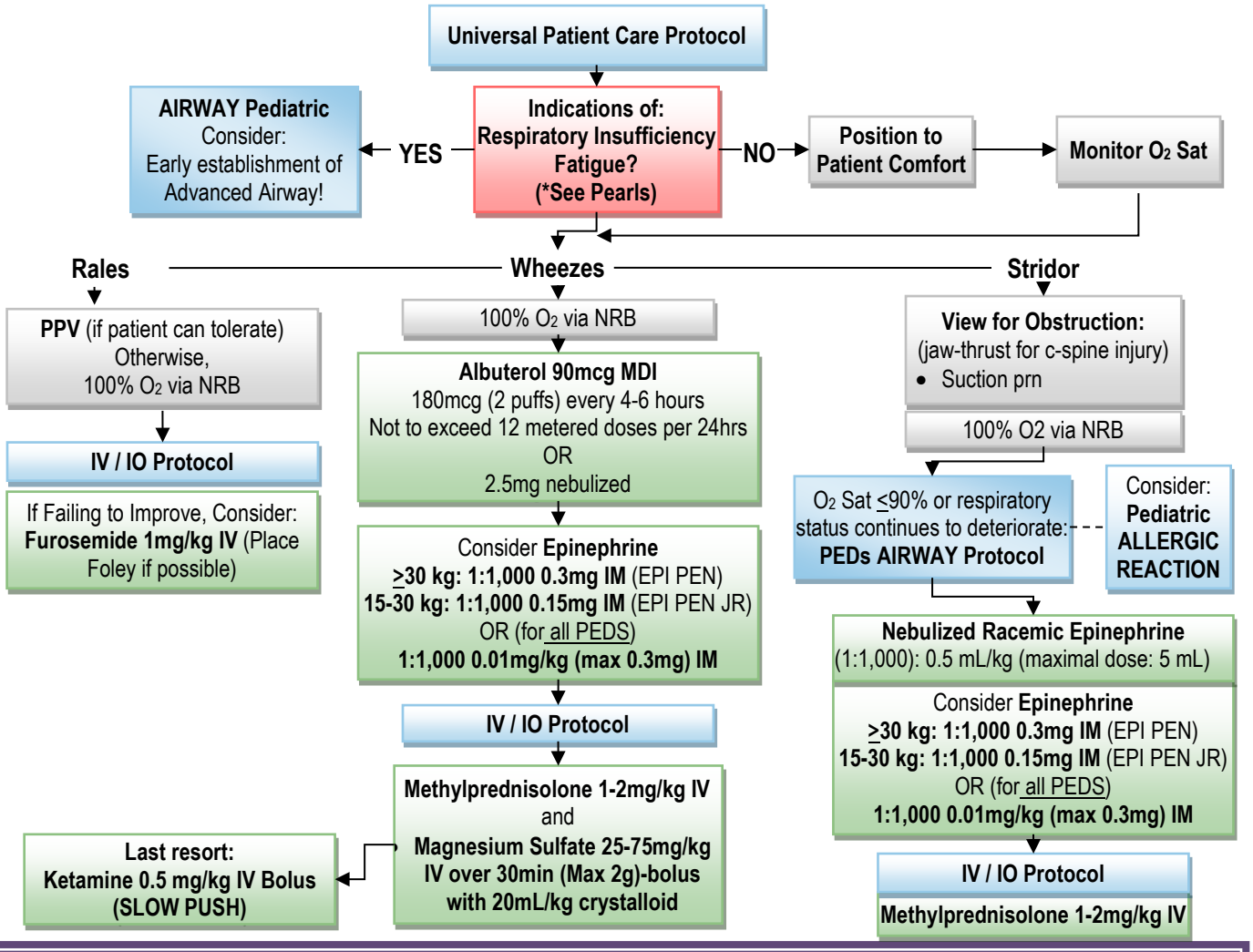


Pearls:

- **Signs of respiratory insufficiency**: Cyanosis, altered mental status / loss of consciousness, fatiguing, inability to speak, or inability to maintain O_2 sat >90% with supplemental O_2.
- Albuterol can be administered with spacer or short (6") section of ventilator tubing to increase delivery if patient unable to perform action appropriately. No max dose of albuterol, repeat as needed for continued wheezing.
- Lack of abnormal breath sounds does not always signify improvement. As respiratory status worsens, there may be inadequate air movement to produce these sounds.

PEDs RESPIRATORY DISTRESS

Signs and Symptoms:	Differential Diagnosis:
• **Shortness of Breath**	• **Asthma**
• **Tri-Pod Position**	• **Anaphylaxis / Allergy**
• **Pursed Lip Breathing**	• **Aspiration**
• **Decreased Ability to Speak**	• **Croup**
• **Tachypnea / Hyperpnea**	• **Pneumonia**
• **Wheezing / Rhonchi / Rales**	• **Epiglottitis**
• **Use Accessory Muscles**	• **Pneumothorax**
• **Fever / Cough**	• **Pericardial Tamponade**
• **Tachycardia**	• **Hyperventilation**
• **Absent Breath Sounds**	• **Toxic Inhalation** (e.g., Cyanide, CO)


Universal Patient Care Protocol
Indications of: Respiratory Insufficiency Fatigue? (*See Pearls)
YES
AIRWAY Pediatric Consider: Early establishment of Advanced Airway!
NO
Position to Patient Comfort
Monitor O2 Sat
Rales
Wheezes
Stridor
PPV (if patient can tolerate) Otherwise, 100% O2 via NRB
IV / IO Protocol
If Failing to Improve, Consider: Furosemide 1mg/kg IV (Place Foley if possible)
100% O2 via NRB
Albuterol 90mcg MDI 180mcg (2 puffs) every 4-6 hours Not to exceed 12 metered doses per 24hrs OR 2.5mg nebulized
Consider Epinephrine ≥30 kg: 1:1,000 0.3mg IM (EPI PEN) 15-30 kg: 1:1,000 0.15mg IM (EPI PEN JR) OR (for all PEDS) 1:1,000 0.01mg/kg (max 0.3mg) IM
IV / IO Protocol
Methylprednisolone 1-2mg/kg IV and Magnesium Sulfate 25-75mg/kg IV over 30min (Max 2g)-bolus with 20mL/kg crystalloid
Last resort: Ketamine 0.5 mg/kg IV Bolus (SLOW PUSH)
View for Obstruction: (jaw-thrust for c-spine injury)
• Suction prn
100% O2 via NRB
O2 Sat ≤90% or respiratory status continues to deteriorate: PEDs AIRWAY Protocol
Consider: Pediatric ALLERGIC REACTION
Nebulized Racemic Epinephrine (1:1,000): 0.5 mL/kg (maximal dose: 5 mL)
Consider Epinephrine ≥30 kg: 1:1,000 0.3mg IM (EPI PEN) 15-30 kg: 1:1,000 0.15mg IM (EPI PEN JR) OR (for all PEDS) 1:1,000 0.01mg/kg (max 0.3mg) IM
IV / IO Protocol
Methylprednisolone 1-2mg/kg IV

Pearls:

- **Signs of respiratory insufficiency**: Cyanosis, altered mental status / loss of consciousness, fatiguing, inability to speak, or inability to maintain O_2 sat >94% with supplemental O_2.
- **Albuterol can be administered with spacer or short (6") section of ventilator tubing to increase delivery if patient unable to perform action appropriately. No max dose of albuterol, repeat as needed for continued wheezing.**
- Lack of abnormal breath sounds does not always signify improvement. As respiratory status worsens, there may be inadequate air movement to produce these sounds. In pediatric patients (especially infants), respiratory insufficiency may be the result of cardiac anatomical anomalies, in addition to standard causes. Peripheral cyanosis is a clue to this condition, and suspicion should be reported to accepting providers upon arrival.

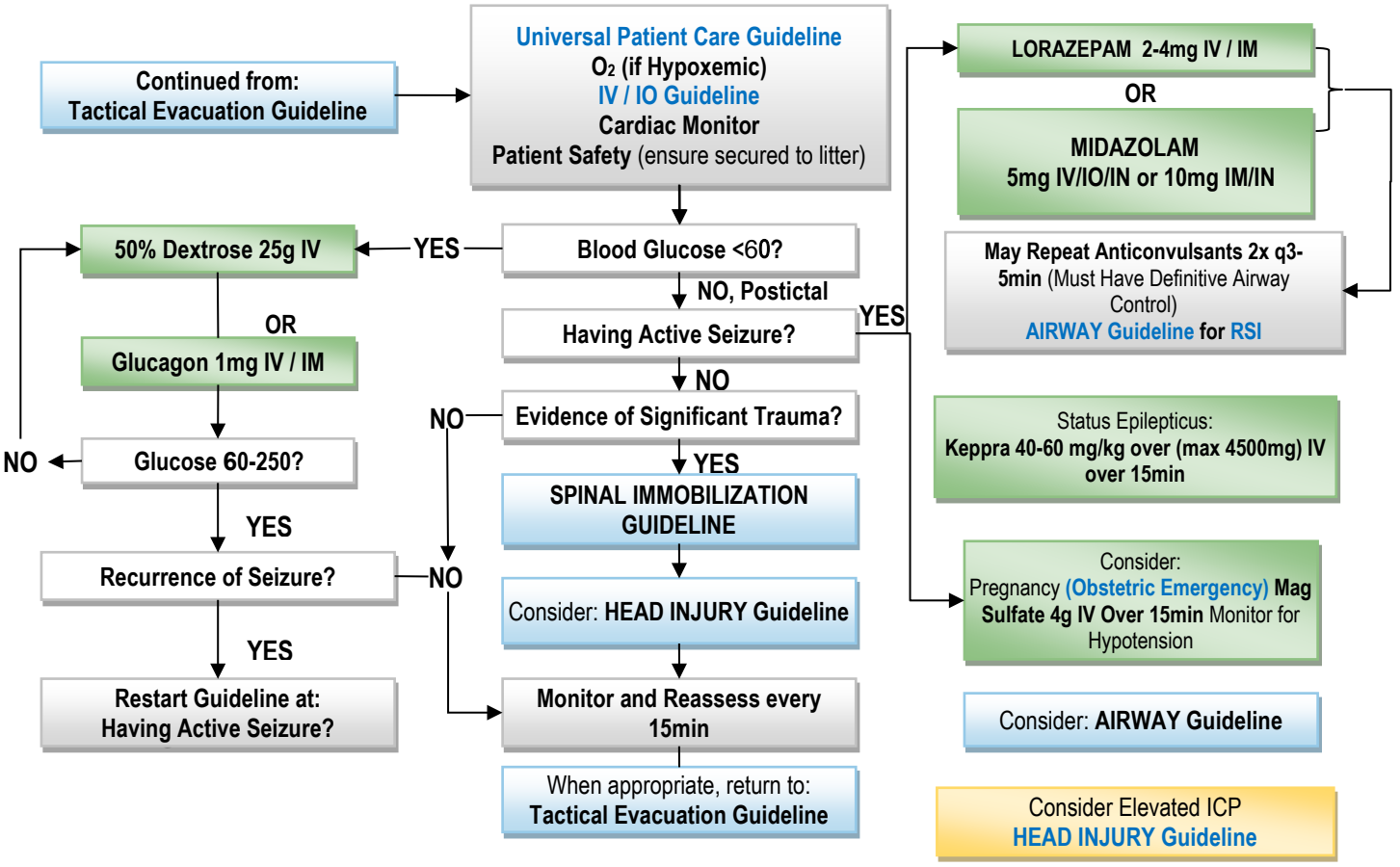
SEIZURE

Signs and Symptoms:

- **Decreased Mental Status**
- **Seizure Activity**
- **Somnolence**
- **Incontinence**
- **Evidence of Trauma**
- **Loss of Consciousness**
- **Oral Injuries (e.g., Tongue, Buccal)**

Differential Diagnosis:

- **CNS Trauma**
- **Tumor / Mass / Infection**
- **Metabolic**
- **Hypoxia**
- **Electrolyte Abnormality**
- **Drugs / Toxins**
- **Alcohol / Benzodiazepine Withdrawal**
- **Stroke**
- **Eclampsia**
- **Hyperthermia**
- **Hypoglycemia**



Pearls:

- Status epilepticus defined as seizure >15min or two or more continuous seizures without a period of consciousness / recovery. This is a real emergency requiring rapid airway control, treatment, and transport to the nearest suitable medical treatment facility.
- **Paralysis for airway control does not stop seizure activity** – only hides it. A seizure is a CNS electrical phenomenon and damage is still being done even when no muscular activity seen due to paralysis.
- Anticipate further seizure activity / recurrence and monitor continually.
- Assess probability of toxin, occult trauma, abuse, or substance use.
- Be prepared to assist with ventilations with the use of midazolam. If airway controlled and ventilating well – may give total of 4 doses of Midazolam.
- In **pregnant patients, Magnesium should be first line to abort non-epileptic seizures**. Midazolam should only be used if this fails (pregnancy class D).
- Adult Alcohol Withdrawal or Malnutrition **(Thiamine 100mg IV**).

Pediatric SEIZURE

Signs and Symptoms:

- **Decreased Mental Status**
- **Seizure Activity**
- **Somnolence**
- **Incontinence**
- **Evidence of Trauma**
- **Loss of Consciousness**
- **Oral Injuries (e.g., Tongue, Buccal)**

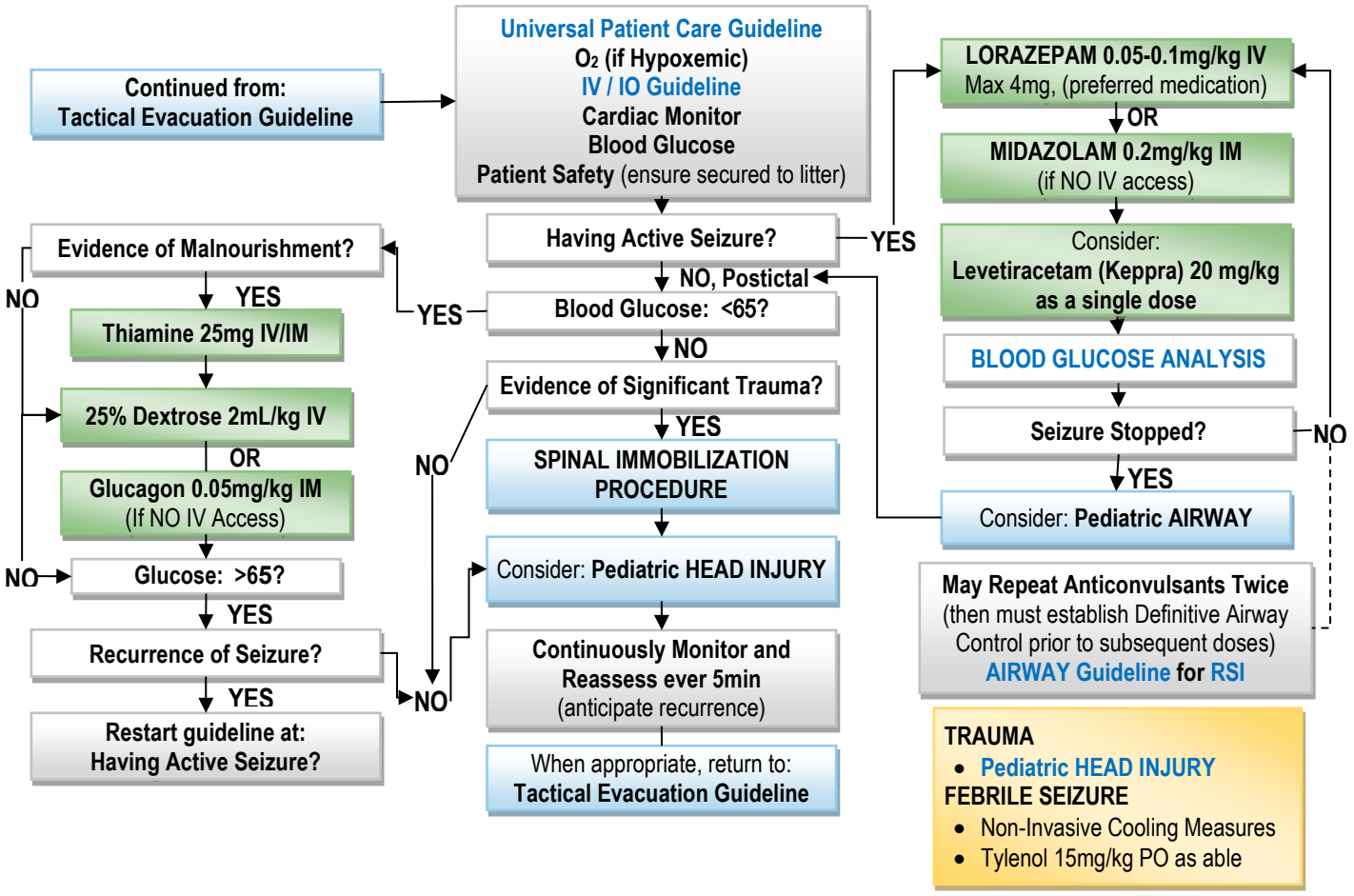
Differential Diagnosis by Age:

Less Than 3 Years Old:

- **Trauma**
- **Fever**
- **Infection**
- **Birth Injury**
- **Drug / Toxin**
- **Metabolic: Hypoglycemia / Electrolyte Abnormality**

More Than 3 Years Old:

- **Trauma, Infection, Brain Degenerative Disease**

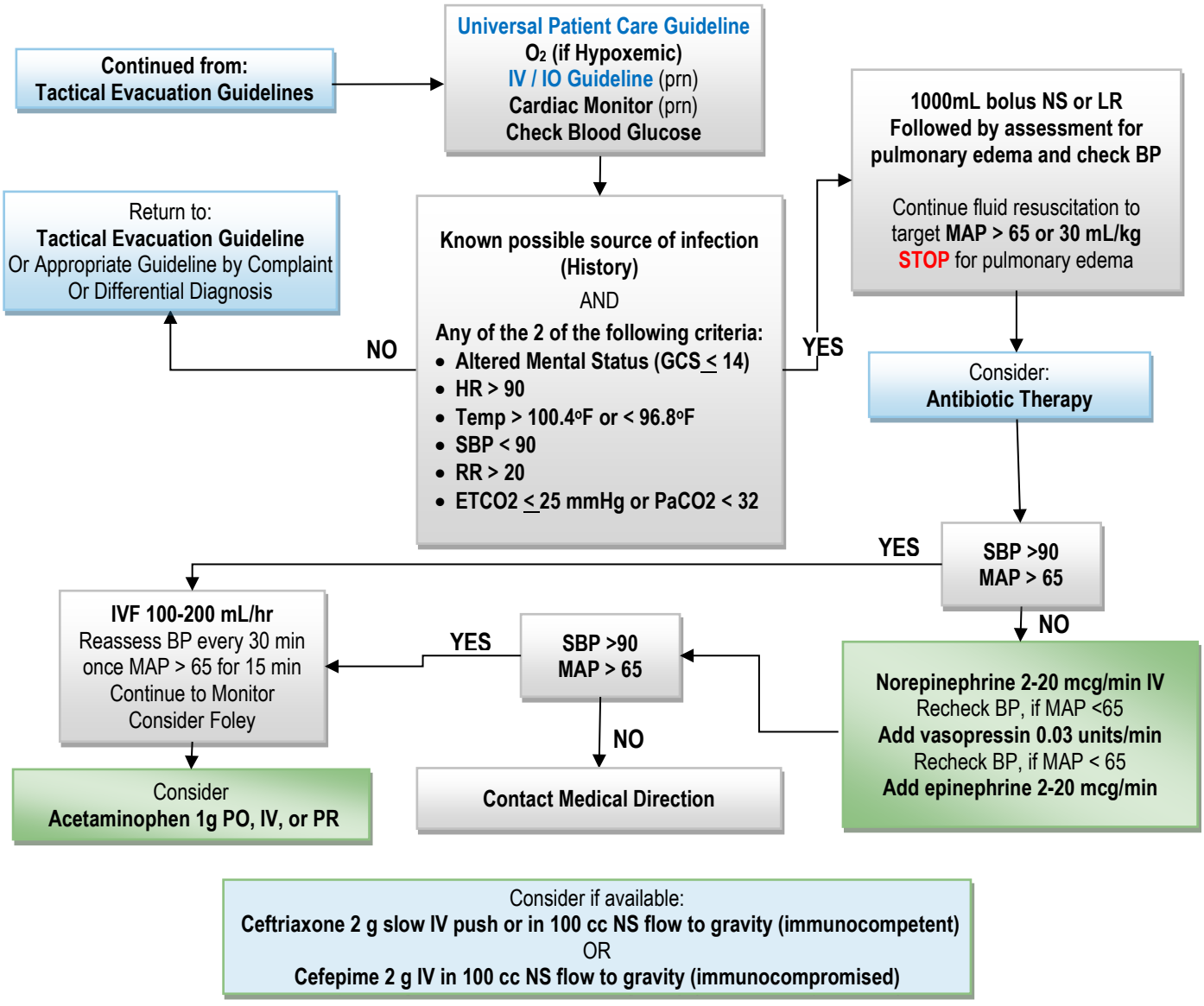


Pearls:

- Status epilepticus defined as seizure >5min or two or more successive seizures without a period of consciousness / recovery. This is a true emergency requiring rapid treatment and transport to nearest suitable medical treatment facility. Ensure adequate airway control is established if medication is administered.
- **Paralysis for airway control does not stop seizure activity** – only hides it. Seizure is a CNS electrical phenomenon and damage is still being done even when no muscular activity seen due to paralysis.
- **Be prepared to assist with ventilations** with the use of Lorazepam / Midazolam. If airway controlled and ventilating well – may give total of 4 doses of Lorazepam.
- MAX DOSES:
  - LORAZEPAM = 4mg/dose, D25 = 25mL/dose, GLUCAGON = 1mg/dose

SEPSIS

History	Signs and Symptoms	Differential Diagnosis:
• Fever • Previous infection • Recent surgery • Immunocompromised (transplant, HIV, diabetes, cancer, etc.) • Wound	• Altered Mental Status • Hyper or hypothermia • Chills • Myalgia • Rigors • Rash • Hyperglycemia • Decreased urine output	• Cardiogenic shock • Hypovolemic shock • CVA • MI • Acute renal failure • Hypoglycemia • Infection not meeting sepsis criteria



Consider if available:
Ceftriaxone 2 g slow IV push or in 100 cc NS flow to gravity (immunocompetent)
OR
Cefepime 2 g IV in 100 cc NS flow to gravity (immunocompromised)

Pearls:

- Early recognition of sepsis allows for attentive care, appropriate fluid resuscitation, vasoactive medications, and early administration of antibiotics.
- Utilize 6-8 mL/kg tidal volumes if artificially ventilated.
- Record urine output if foley in place. Decreased urine output is an indicator of patient deterioration.
- Use vasopressin despite less than maximal norepinephrine. Consider adding it when titrating above 8-10 mcg/min IV norepinephrine. Continue it once started and decrease norepinephrine to MAP goal.

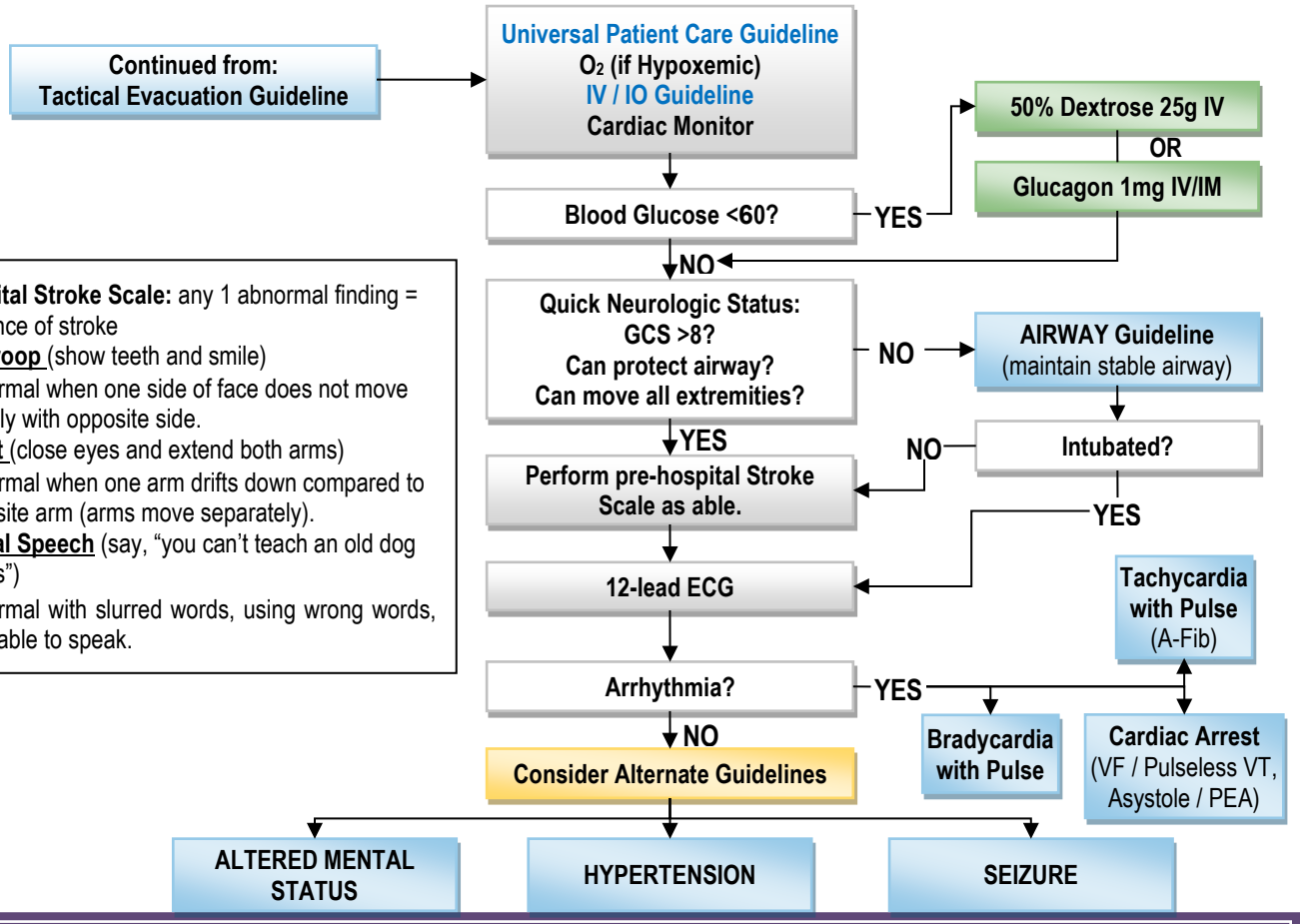
SUSPECTED STROKE / TIA

Signs and Symptoms:

- **Altered Mental Status**
- **Weakness / Paralysis**
- **Blindness or Other Sensory Loss**
- **Aphasia / Dysarthria**
- **Syncope**
- **Vertigo / Dizziness**
- **Vomiting**
- **Headache**
- **Seizures**

Differential Diagnosis:

- **Transient Ischemic Attack**
- **Stroke**
- **Seizure**
- **Hypoglycemia**
- **CNS Infection / Mass**
- **Trauma**
- **Metabolic**



Prehospital Stroke Scale: any 1 abnormal finding = 72% chance of stroke

Facial Droop (show teeth and smile)

- Abnormal when one side of face does not move equally with opposite side.

Arm Drift (close eyes and extend both arms)

- Abnormal when one arm drifts down compared to opposite arm (arms move separately).

Abnormal Speech (say, "you can't teach an old dog new tricks")

- Abnormal with slurred words, using wrong words, or unable to speak.

Pearls:

- Duration of symptoms should be determined as accurately as possible. Family members / colleagues can be helpful. If pt awaken with symptoms – onset time est. from last time patient was seen "normal."
- Be alert for airway problem / risk of aspiration. If concerned, request intubation before departure.
- Hypoglycemia can mimic stroke / TIA. May present with focal neurologic deficit, especially in the elderly.
- EKG should be obtained in all patients to evaluate for arrhythmia – especially atrial fibrillation.
- All TIAs should be transferred for evaluation, even if symptoms abated – these patients have a 10% risk of stroke within 30 days.
- **Aspirin should not be given to patients for suspected stroke.** Aspirin use is a contraindication to the use of thrombolytics for stroke.
- All strokes/TIAs are not associated with motor findings. Although uncommon, pure sensory strokes can occur. More frequently, very subtle motor abnormalities are present that the patient may not note.
- **Systolic greater than 185 or Diastolic greater than 110**: give Labetalol **10-20 mg IV for 1-2 minutes**. May repeat 1 time.
- **Aim for no more than a 20% reduction in MAP. MAP = [(2 x Diastolic) + Systolic] / 3** For additional info see: ALS Acute Coronary Syndromes and Stroke.

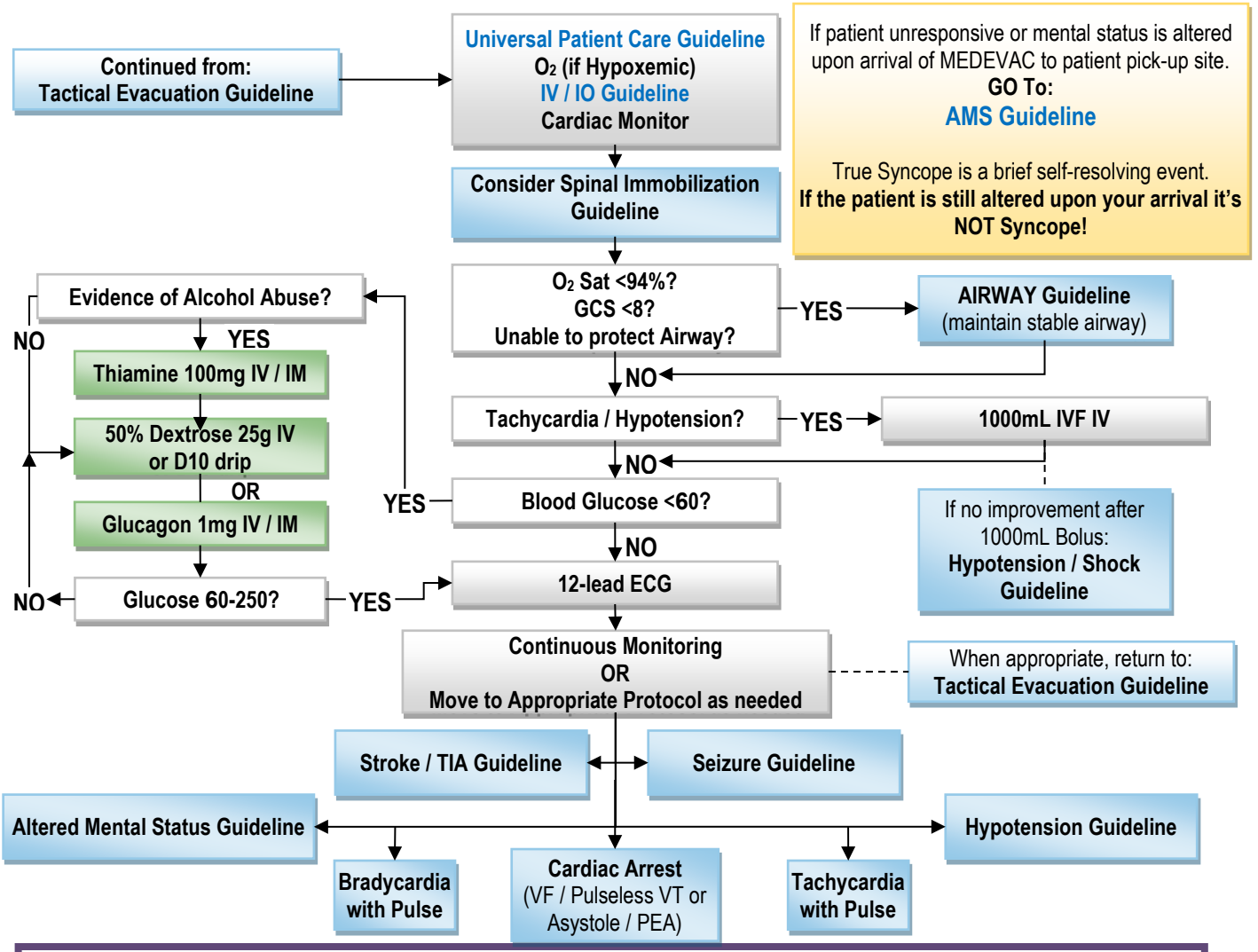
SYNCOPE

Signs and Symptoms:

- Loss of Consciousness with Recovery
- Lightheadedness / Dizziness
- Nausea / Vomiting
- Palpitations / Chest Pain
- Shortness of Breath
- Decreased Pulse Pressure

Differential Diagnosis:

- Vasovagal Episode
- Orthostatic Hypotension
- Cardiac Etiology
- Psychiatric
- Stroke
- Hypoglycemia
- Seizure
- Shock
- Toxicologic / Medication



Pearls:

- Assess every patient for signs of trauma if suspected with syncopal event.
- Consider occult bleeding in all cases of syncope: GI bleeding, ruptured ectopic pregnancy, and seizure.
- Prodromal symptoms (e.g., flushing, lightheadedness, diaphoresis, tunnel vision) are often associated with more innocent etiologies, especially if temporally related to standing / rising. Absence of prodrome should raise concern for cardiac / CNS (emergent) etiologies.
- It is uncommon for stroke to cause syncopal episode.
- Patients who sustain trauma to the temporal region of the skull and are now lucid may experience a precipitous loss of consciousness / degeneration due to epidural hematoma.

TOXIC INGESTIONS

Signs and Symptoms:
- **Mental Status Changes**
- **Hypo / Hypertension**
- **Respiratory Depression**
- **Tachycardia / Arrhythmias**
- **Seizure**

Differential Diagnosis:
- **Cyclic Antidepressants**
- **Acetaminophen**
- **Depressants**
- **Stimulants**
- **Anticholinergic**
- **Cardiac Medications**
- **Solvents / Cleaners**
- **Organophosphate / Carbamate**
- **Medical Cause (hyperthyroidism)**

Continued from: Tactical Evacuation Guideline

Universal Patient Care Guideline
O_2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)

If possible,
Contact Poison Control Center or Medical Control if toxin known or for treatment advice
In US: 1-800-222-1222

Supportive care is keystone in management of toxic ingestions:
- Continuous monitoring, supplemental O_2 / airway support, IVF resuscitation

Blood Sugar <60?
- YES → **Altered Mental Status Guideline** (50% Dextrose 25g in 500mL NS IV or Glucagon 1mg IM if no IV)
- NO → **IV Bolus PRN**

TriCyclic Overdose:
QRS >100 = Predictive of seizures
QRS >160 = Predictive of VT

Activated Charcoal 1gram/kg PO (If alert / protecting airway and time of ingestion <1hr)

Beta Blocker Overdose:
AV Block (especially, 1st Degree), Bradycardia, and Hypotension:
Consider giving: Glucagon 3-10mg IV / IM Bolus followed by 3-5mg/hr infusion

Opiates (Respiratory Depression)
- **Naloxone 0.4-2mg IV / IO**
- **Airway Guideline**

TriCyclic Antidepressant
- **12 Lead EKG**
- **QRS >100ms or Hypotensive?**
- **Sodium Bicarbonate 1mEq/kg**
  May repeat to maintain QRS <100
  Start Maintenance Infusion:
  100-150mEq (2-3 amps) in 1 L D5 / NS @ 100-200 mL/hr IV

Organophosphate / Carbamate
- **Atropine 2mg IV / IO q5min** (No max dose: give until improving with ↓ secretions)
- **2-PAM 600mg IV / IM** (Atropine + 2-PAM = Mark 1 Kit)
- **If in Seizure give:**
- **Midazolam 2.5-5mg IV/IM x 2**
- **Seizure Guideline**

Other
- **12-lead EKG**
- **Hypotension, Seizures, Ventricular Dysrhythmias, Altered Mental Status, Chest Pain**
- **Appropriate Guideline**

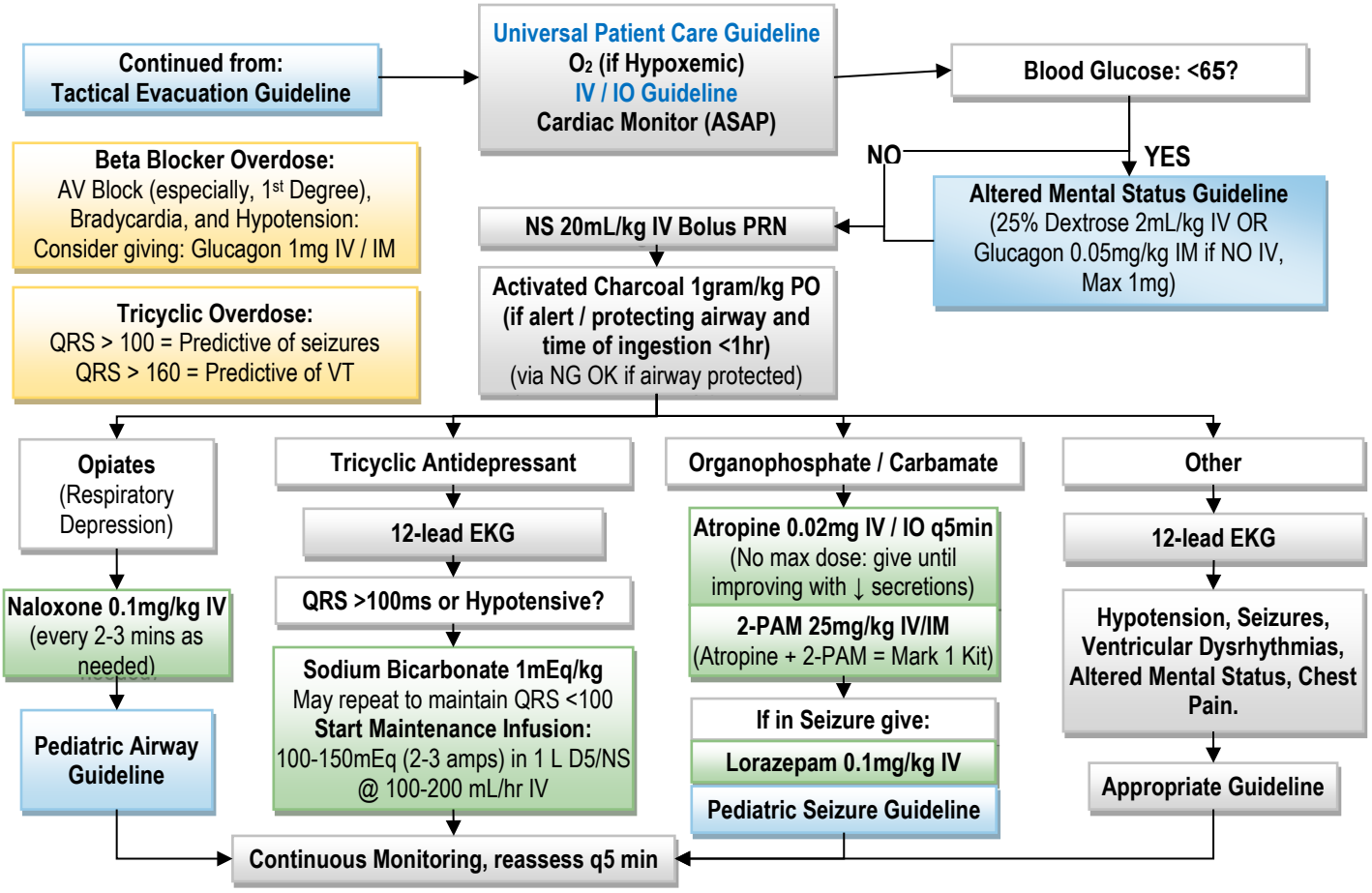
Continuous Monitoring, reassess q5 min

Pearls:
- **Anticholinergic**: Altered mental status (mad as a hatter), Hyperthermia (hot as a hare), mydriasis (blind as a bat), Flushing (red as a beet), anhidrosis (dry as a bone), Full Bladder (full as a flask).
  - Treat as with Tricyclic overdose pathway (including EKG and Sodium Bicarb for prolonged QRS and/or arrhythmias)
  - LORAZEPAM for agitation and seizures and Hyperthermia Guideline if hyperthermic
- **Beta Blocker**: Hypoglycemia.
- **Calcium Channel Blocker:** HypERglycemia.
- **Cyclic Antidepressant:** Hypotension, depressed mental status, respiratory depression, cardiac arrhythmias.
- **Opioid:** Depressed mental status, pinpoint pupils, N/V, respiratory depression, hypotension possible.
- **Organophosphate / Carbamate (Cholinergic):** Salivation, lacrimation, urination, diarrhea, emesis, altered mental status.
- **Sympathomimetic / Stimulant (Methamphetamine / Cocaine)**: Altered mental status, tachycardia, diaphoresis, mydriasis, and hyperthermia. Treat with Benzodiazepine (LORAZEPAM) and PRN cooling or Hyperthermia Guideline.

Pediatric TOXIC INGESTIONS

Signs and Symptoms:
- **Mental Status Changes**
- **Hypo / Hypertension**
- **Respiratory Depression**
- **Tachycardia / Arrhythmias**
- **Seizure**

Differential Diagnosis:
- **Cyclic Antidepressants**
- **Acetaminophen**
- **Depressants**
- **Stimulants**
- **Anticholinergic**
- **Cardiac Medications**
- **Solvents / Cleaners**
- **Organophosphates / Carbamate**
- **Medical Cause (hyperthyroidism)**



Pearls:
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VOMITING & DIARRHEA

Signs and Symptoms:

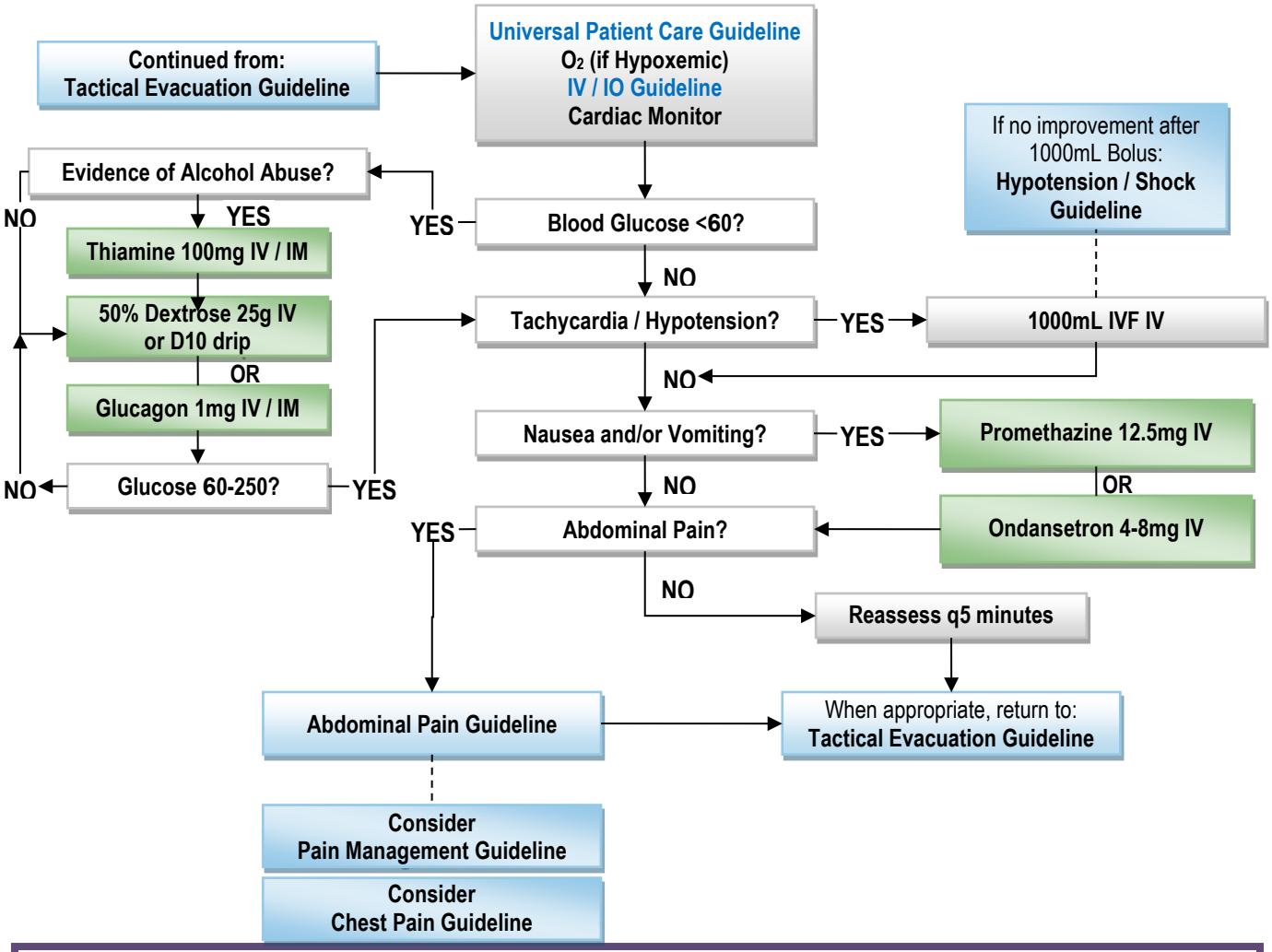
- Pain
- Abdominal Distention
- Constipation
- Diarrhea
- Anorexia

Associated Symptoms:

Fever, Headache, Weakness, Malaise, Myalgia, Cough, Dysuria, Mental Status Changes, Rash

Differential Diagnosis:

- CNS Injury / Mass / Infection
- Myocardial Infarction
- Drugs / Toxins
- Bowel Obstruction
- Diabetic Ketoacidosis
- Pregnancy
- Infections
- Gastroenteritis
- Food Borne / Toxic
- Psychologic
- Appendicitis



Pearls:

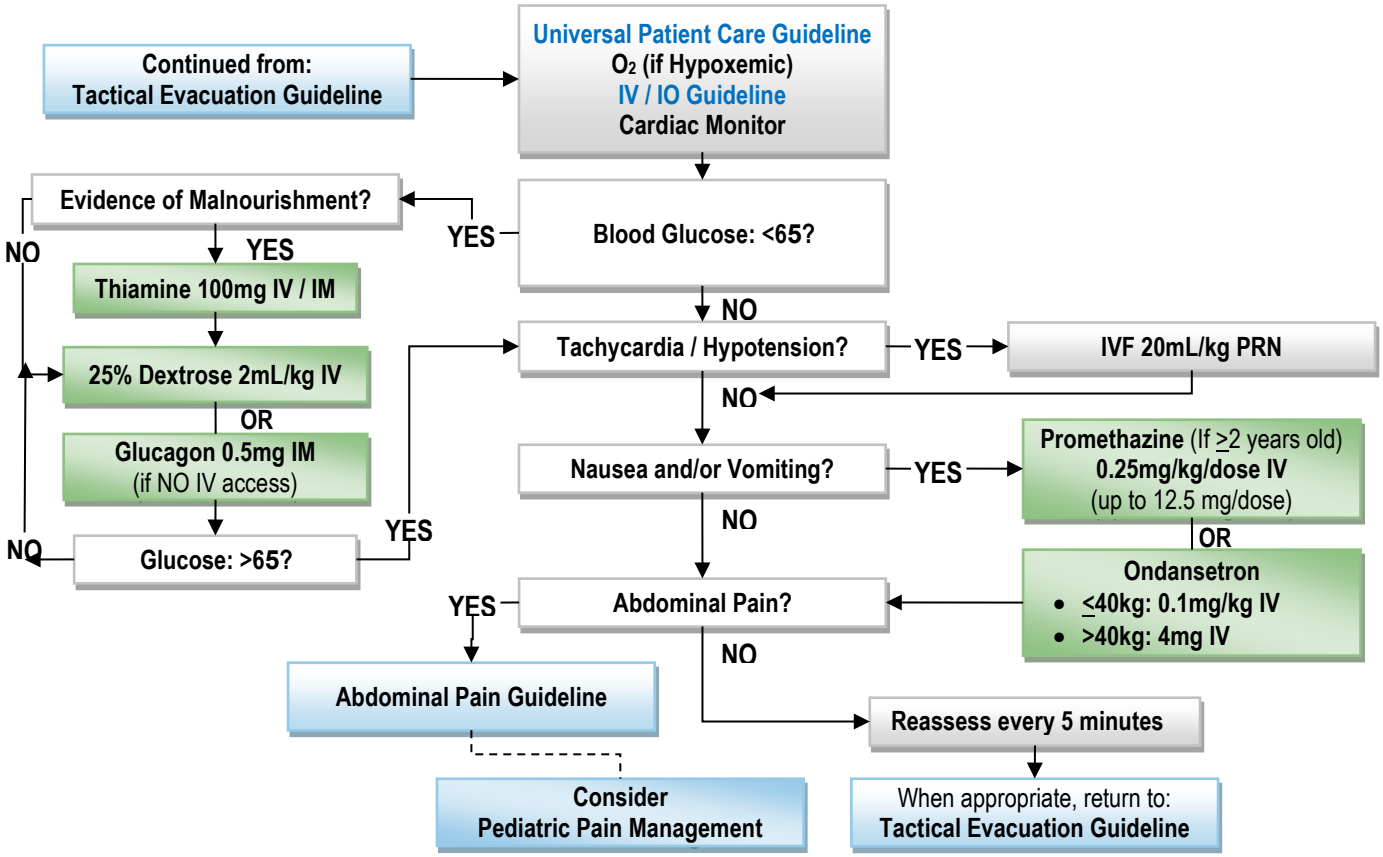
- Suspicion of other underlying condition should prompt immediate referral to appropriate protocol.
- In pregnant patients with nausea / vomiting – can substitute D5 1/2NS or D5NS in place of NS.
- Fluid of choice for vomiting is NS. Fluid of choice for diarrhea is LR.
- Continually monitor for any decompensation.

Pediatric VOMITING & DIARRHEA

Signs and Symptoms:
- Pain
- Abdominal Distention
- Constipation
- Diarrhea
- Anorexia

Associated Symptoms:
Fever, Headache, Weakness, Malaise, Myalgia, Cough, Dysuria, Mental Status Changes, Rash

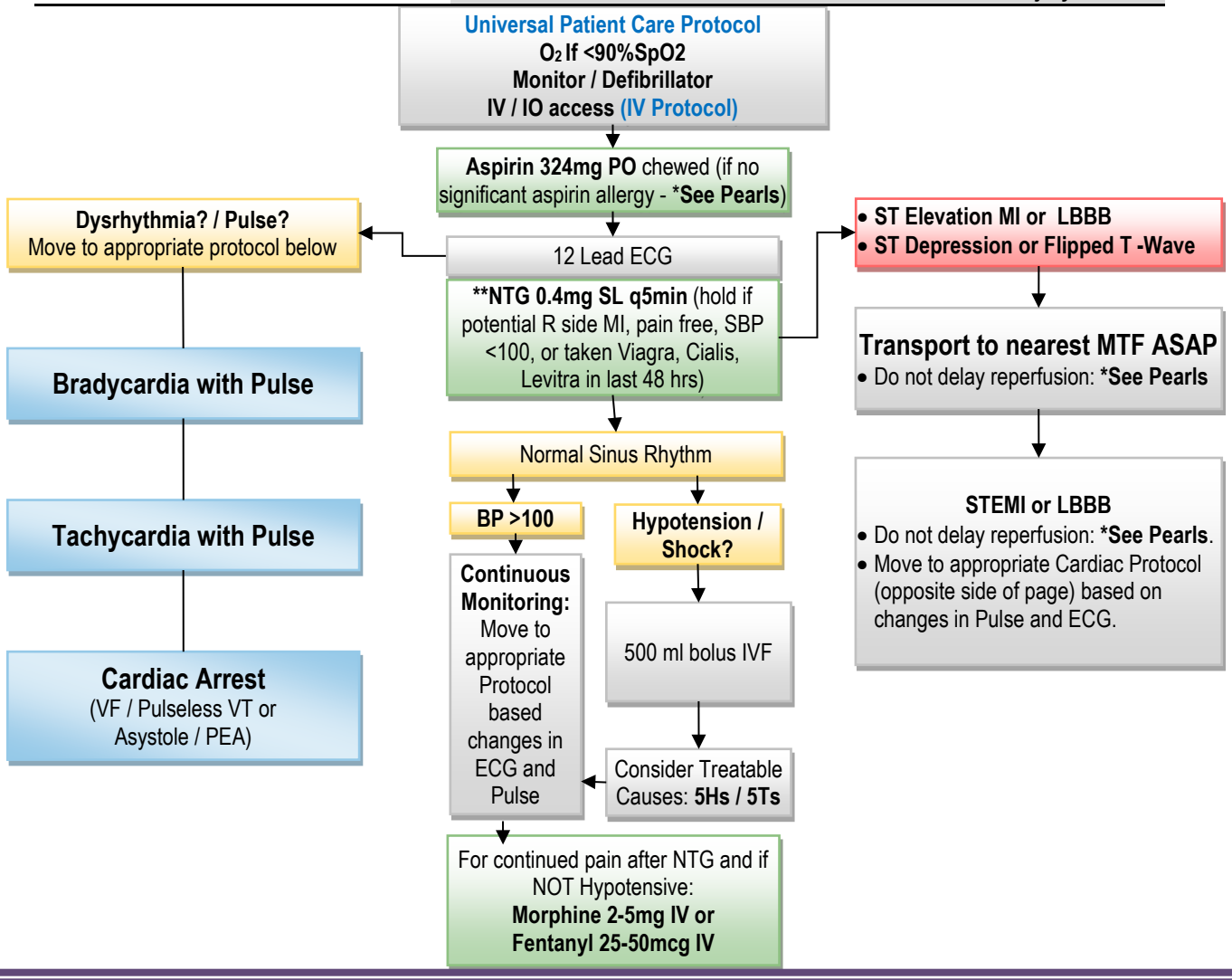
Differential Diagnosis:
- CNS Injury / Mass / Infection
- Myocardial Infarction
- Drugs / Toxins
- Bowel Obstruction
- Diabetic Ketoacidosis
- Pregnancy
- Infections
- Gastroenteritis
- Food Borne / Toxic
- Psychologic
- Appendicitis



Pearls:
- Suspicion of other underlying condition should prompt immediate referral to appropriate guideline.
- Continually monitor for any decompensation.

CHEST PAIN

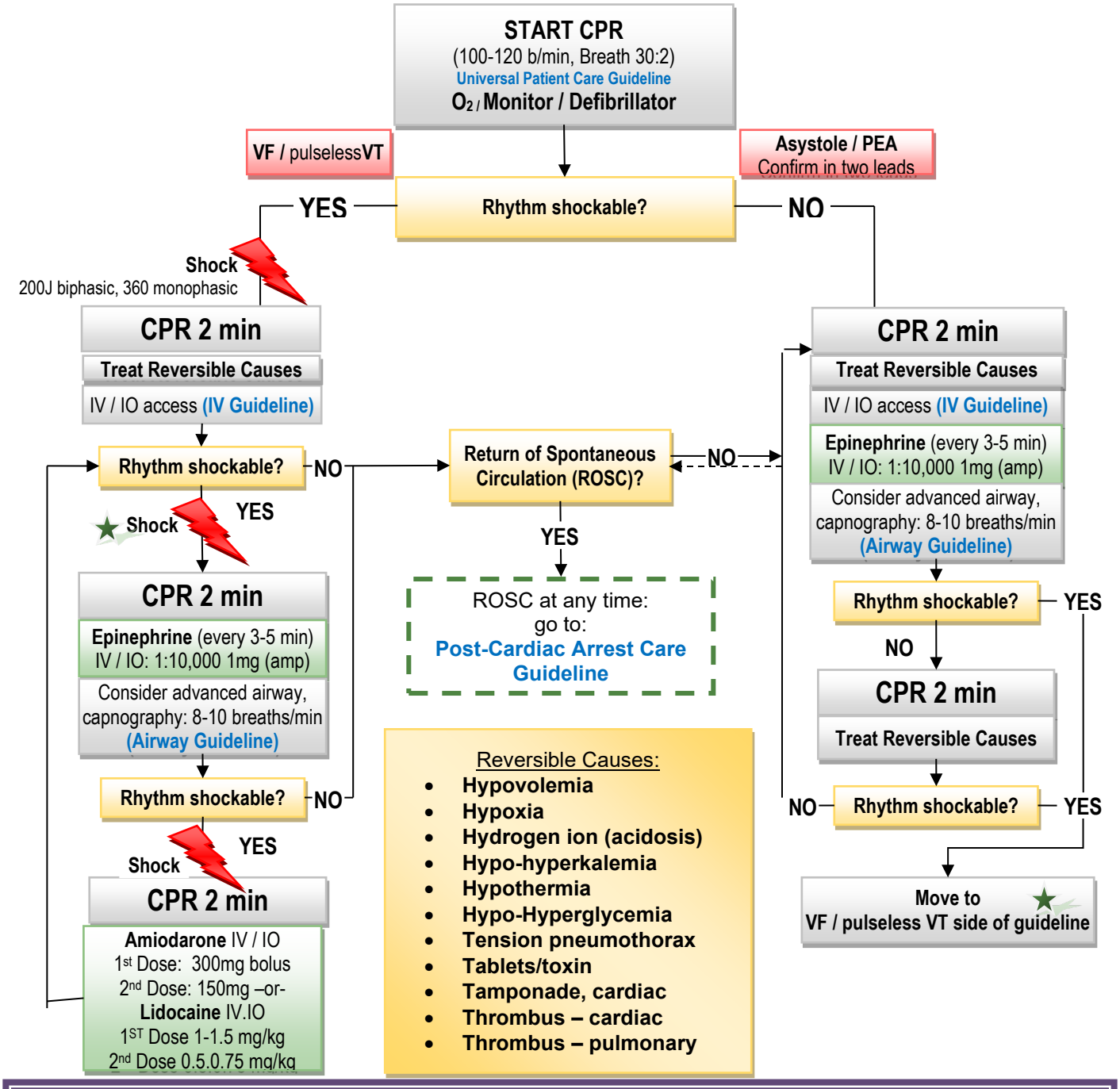
Signs and Symptoms:	Differential Diagnosis:	Differential Diagnosis:
• **Chest Pain** • **Radiation of Pain** • **Location of Pain** • **Pale / Diaphoretic / Lightheaded** • **Nausea / Vomiting** • **Shortness of Breath**	• **Angina** • **Acute MI** • **Pericarditis** • **Pulmonary Embolism** • **Asthma / COPD** • **Pneumothorax**	• **Aortic Dissection / Aneurysm** • **GERD** • **Esophageal Spasm** • **Esophageal perforation** • **Chest Wall Injury / Pain**


Universal Patient Care Protocol
O2 If <90%SpO2
Monitor / Defibrillator
IV / IO access (IV Protocol)
Aspirin 324mg PO chewed (if no significant aspirin allergy - *See Pearls)
12 Lead ECG
**NTG 0.4mg SL q5min (hold if potential R side MI, pain free, SBP <100, or taken Viagra, Cialis, Levitra in last 48 hrs)
Normal Sinus Rhythm
BP >100
Hypotension / Shock?
500 ml bolus IVF
Consider Treatable Causes: 5Hs / 5Ts
Continuous Monitoring: Move to appropriate Protocol based changes in ECG and Pulse
For continued pain after NTG and if NOT Hypotensive:
Morphine 2-5mg IV or
Fentanyl 25-50mcg IV
Dysrhythmia? / Pulse?
Move to appropriate protocol below
Bradycardia with Pulse
Tachycardia with Pulse
Cardiac Arrest
(VF / Pulseless VT or Asystole / PEA)
• ST Elevation MI or LBBB
• ST Depression or Flipped T -Wave
Transport to nearest MTF ASAP
• Do not delay reperfusion: *See Pearls
STEMI or LBBB
• Do not delay reperfusion: *See Pearls.
• Move to appropriate Cardiac Protocol (opposite side of page) based on changes in Pulse and ECG.

Pearls:

- **Aspirin** should be held only for patients with known significant allergy.
- Patients with suspected AMI should be transferred to the nearest MTF for further treatment / thrombolytics.
- **With right sided MI (ST Elevations in leads II, III, AvF), NTG may cause hypotension so use with caution. Add small fluid boluses for low BP.
- Ensure that you have IV access before giving SL NTG.
- **Hold Morphine or Fentanyl for SBP <90**.
- Max dose Morphine 20mg, Fentanyl 200mcg for non-traumatic chest pain (higher doses may be required for trauma, see Pain Control algorithm).

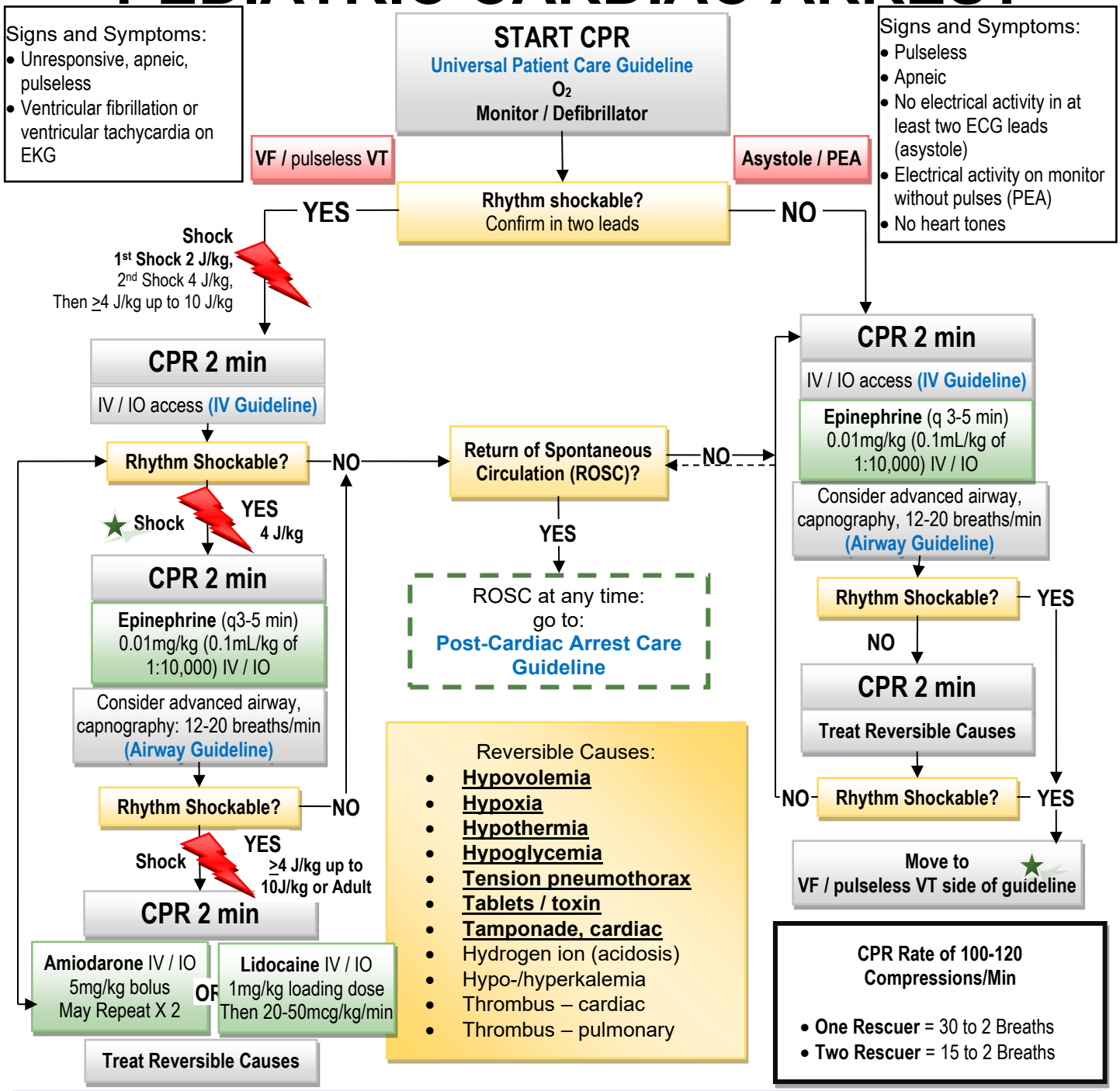
CARDIAC ARREST



Pearls:

- Reversible causes should be addressed as soon as possible.
- Consider discontinuation of efforts if:
  - Asystole following trauma – especially blunt.
  - Prolonged downtimes - > 15min.
  - Prolonged code with no response - >3 rounds of medications, 30min of resuscitation.
  - **All patients should get a glucose check, at least 1L fluid bolus, and ultimately bilateral needle decompression (especially in Trauma) before discontinuation of efforts.**
  - Should take at least 1min to check for pulse in hypothermic patients.

PEDIATRIC CARDIAC ARREST



Pearls:

- **CPR Rate of 100-120 / Min 2 inches depth for children and 1 1/2 inches depth for infants of chest with complete chest recoil**
  - Reversible causes should be addressed as soon as possible.
  - Epinephrine Endotracheal Dose: 0.1 mg/kg (0.1mL/kg of 1:1,000 vial)
  - Consider discontinuation of efforts if:
    - Asystole following trauma – especially blunt
    - Prolonged downtimes - > 15min
    - Prolonged code with no response - >3 rounds of medications, 30min of resuscitation
    - **All patients should get a glucose check, at least 20ml/kg fluid bolus of NS, and ultimately bilateral needle decompression (Trauma) before discontinuation of efforts**

PEDIATRIC ALS and BLS INDICATORS

Indicators of Potential Need for Cardiopulmonary Support

- **Breathing**
  - Irregular Respirations or >60 breaths/min
  - Labored Breathing (Retractions, Nasal Flaring, Grunting, Pursing of Lips, Tripod Positioning, ↓Ability to Speak)
- **Heart Rate Ranges** (especially if associated with poor perfusion)
  - ≤2 Years Old: <80/min or >180/min
  - >2 Years Old: <60/min or >160/min
- **Poor Perfusion with Weak or Absent Distal Pulses**
  - Cyanosis
  - ↓O_2 Sat
- **Altered Mental Status**
  - GCS <8, Weak Cry, Unusual Irritability, Altered Responsiveness, Lethargy, or Failure to Respond to Painful Stimulus
- **Seizures, Fever with Petechiae, Trauma, and/or Burns >10% Body Surface Area**

IOT Prevent Cardiac Arrest You Must Detect and Treat:
Respiratory Failure / Respiratory Arrest / Shock
Pediatric Cardiac Arrest Results from Deterioration in Respiratory or Cardiac Function!

Heart Rate/Min

Age	Awake Rate	Mean	Sleeping Rate
Newborn to 3mo	85-205	140	80-160
3mo - 2y	100-190	130	75-160
2 - 10y	60-140	80	60-90
>10y	60-100	75	50-90

Respiratory Rate/Min

Age	Rate
Infant	30-60
Toddler	24-40
Preschool	22-34
School	18-30
Adolescent	12-16

Blood Pressure	Average	Lower Limit
1-10y	90+(years old x 2)mmHg	70+(years old x 2)mmHg
>10y		90mmHg
MAP	55+(years old x 1.5)mmHg	

Rescue Breathing Ventilation Rate Without Advanced Airway:
- **NEWBORN** = 40-60/min when performed without compressions
- **Infant / Child** = 1 breath / 3 to 5 seconds

CPR Rate of 100 Compressions / Min at:
- **One Rescuer** = 30 Compressions and 2 Breaths
- **Two Rescuer** = 15 Compressions and 2 Breaths

Universal Patient Care
O_2 (100% FiO_2)
Monitor / Defibrillator
IV / IO access (IV Protocol)

Unresponsive, Not Breathing or ALS Indicators

Check Pulse (up to 10 sec)

DEFINITE Pulse
- GIVE: 1 Breath every 3-5 seconds
- Ensure adequate oxygenation & ventilations
- Recheck Pulse every 2 minutes
  - Add compressions if pulse <60/min despite O_2 and Ventilation
  - Move to appropriate Guideline

Rapid Pulse with good perfusion?
→ **PEDs Tachycardia with Pulse & Adequate Perfusion**

Rapid Pulse with poor perfusion despite O_2 and ventilation?
→ **PEDs Tachycardia with Pulse & Poor Perfusion**

Pulse <60/min with poor perfusion despite O_2 and ventilation?
→ **Begin CPR and move to appropriate protocol**
→ **PEDs Bradycardia with Pulse & Poor Perfusion**

No Pulse?
→ **Begin CPR and move to appropriate protocol**
→ **Pediatric Cardiac Arrest**

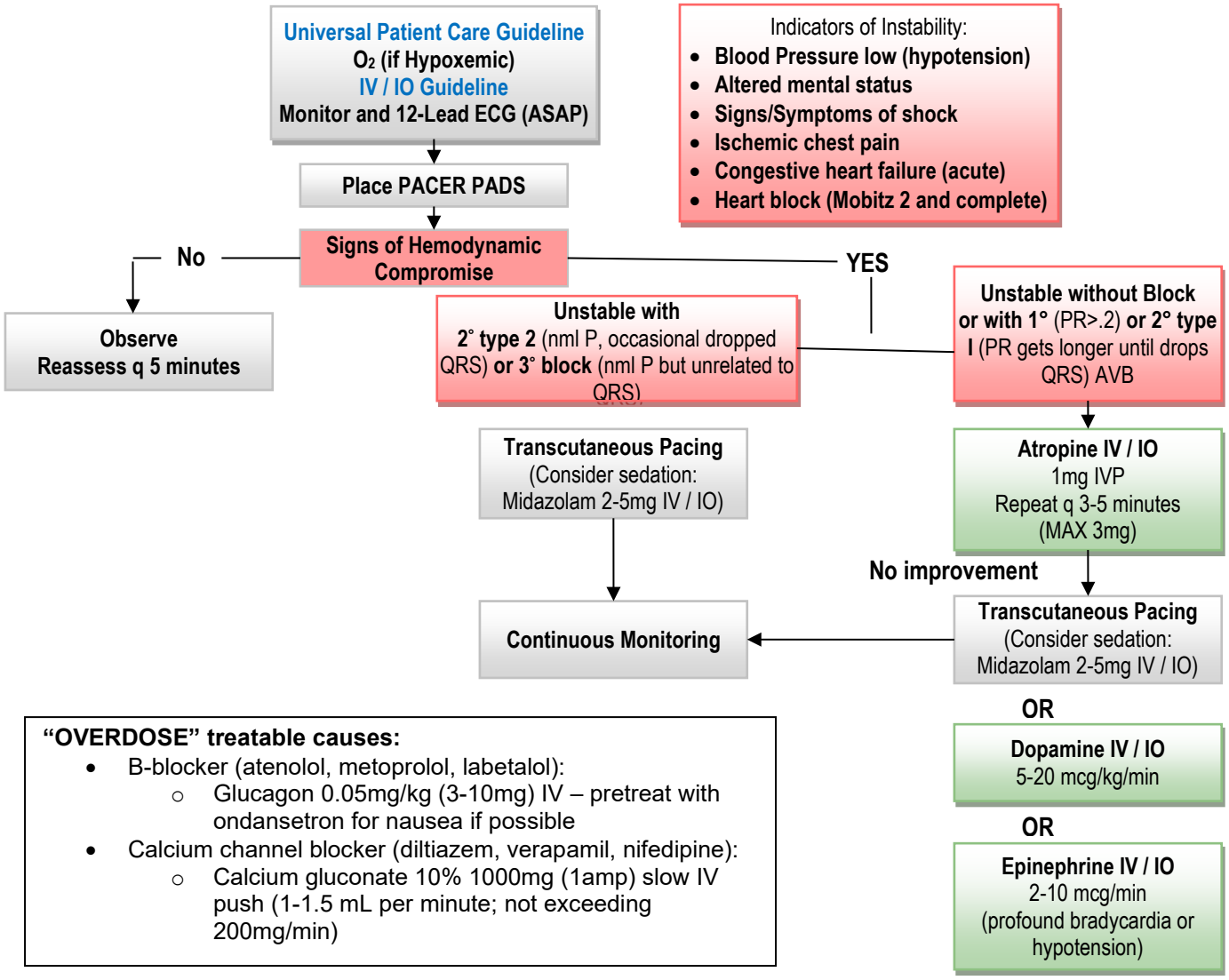
BRADYCARDIA with PULSE

Signs and Symptoms:

- HR <50bpm
- Chest Pain
- Respiratory Distress
- Hypotension / Shock
- Altered Mentation
- Syncope

Differential Diagnosis:

- Acute MI
- Hypoxia
- Hypothermia
- Sinus Bradycardia
- Physiologic Bradycardia (Athletes)
- Stroke
- Spinal Cord Lesion
- Toxin / Medications (B-blockers)
- AV Block / Sick Sinus Syndrome



"OVERDOSE" treatable causes:

- B-blocker (atenolol, metoprolol, labetalol):
  - Glucagon 0.05mg/kg (3-10mg) IV – pretreat with ondansetron for nausea if possible
- Calcium channel blocker (diltiazem, verapamil, nifedipine):
  - Calcium gluconate 10% 1000mg (1amp) slow IV push (1-1.5 mL per minute; not exceeding 200mg/min)

Pearls:

- Decompensation at any time (e.g., altered MS, hypotension) should prompt treatment as unstable patient.
- All bradycardic patients should have pacer pads in place after initial evaluation.
- Epinephrine infusion for refractory bradycardia: 2-10 mcg/min or 0.1-0.5 mcg/kg/minute (7 to 35 mcg/min in a 70 kg patient)
  - 1mg 1:10,000 in 250mL D5W / NS = 4 mcg/mL concentration
- Evaluate for treatable causes of bradycardia (B-blockade, Ca Channel blockade).

PEDIATRIC BRADYCARDIA with Pulse and Poor Perfusion

Typical HR/min

- Newborn 85 - 205
- 3mth - 2y/o 100 - 190
- 2y/o - 10y/o 60 -140
- >10 y/o 60 - 100

Typical Sinus Tachycardia Rates

- **Infants <220/min**
- **Children <180/min**

Indicators of CARDIOPULMONARY COMPROMISE

- **Hypotension**
  - 1-10 y/o lower limit = 70+(years old x 2)mmHg
  - >10 y/o lower limit = 90mmHg
- **Acutely Altered Mental Status**
  - GCS <8, Weak Cry, Unusual Irritability, Altered Responsiveness, Lethargy, or Failure to Respond to Painful Stimulus
- **Signs of Shock**

Identify and Treat Underlying Cause!
Continue:
Universal Patient Care Guideline
- **Maintain Airway / Assisted Breathing**
- **O_2** (Titrate to 94-99% SpO_2)
- **IV / IO access** (IV Guideline)
- **Monitor and 12-Lead ECG (ASAP)**
- **Check Glucose**

Rescue Breathing Ventilation Rate Without Advanced Airway:
- **NEWBORN** = 40-60/min when performed without compressions
- **Infant / Child** = 1 breath / 3 to 5 seconds

CPR Rate of 100 Compressions / Min at:
- **One Rescuer** = 30 Compressions and 2 Breaths
- **Two Rescuer** = 15 Compressions and 2 Breaths

Cardiopulmonary Compromise Continues?

YES → **CPR if HR <60/min** with Poor Perfusion despite O_2 and Ventilation

NO →
- **Support ABCs**
- **Continue O_2**
- **Continuous Monitoring**
- **Consider Consultation**

Bradycardia Persists?

NO → (Support ABCs / Continue O_2 / Continuous Monitoring / Consider Consultation)

YES →

Epinephrine 1:10,000
0.01mg/kg IV/IO q3-5min

Atropine
0.02mg/kg IV / IO
(Increased Vagal Tone or Primary AV Block)
May Repeat Once
(Minimum dose 0.1mg
Max Single dose 0.5mg)

Consider:
Transcutaneous Pacing
(Consider sedation:
Midazolam 0.05-0.1mg/kg IV / IO)

Treat Underlying Causes
- **Support ABCs**
- **Continue O_2**
- **Continuous Monitoring**
- **Consider Consultation**

Check Pulse every 2 minutes during CPR

If Pulse is lost, GO TO:
PEDIATRIC CARDIAC ARREST

Treatable causes:
- **Check & Treat compromise in ABCs**
- **Hypoglycemia**
  - D25 2mL/kg slow IV (max 25mL)
  - Glucagon 0.025mg/kg IM (max 1mg)
- **Tension Pneumothorax**

"OVERDOSE (Mothers Milk)**":**
- **B-blocker** (atenolol, metoprolol, labetalol):
  - Glucagon 0.05mg/kg (3-10mg) IV – **pretreat with ondansetron (0.15mg/kg** – max 2mg) for nausea if possible
- **Calcium channel blocker** (dilitiazem, verapamil, nifedipine)
  - Calcium chloride 10% 0.2ml/kg slow IV push
- **Narcotic**
  - Naloxone 0.1mg/kg IV / IM (max 2mg) every 2-3 mins PRN

Pearls:
- Decompensation at any time (e.g., altered MS, hypotension) should prompt treatment as unstable patient.
- All bradycardic patients should have pacer pads in place after initial evaluation.
- Evaluate for treatable causes of bradycardia (B-blockade, Ca channel blockade).
- The majority of pediatric cardiac problems are actually airway problems.
- In young, breast fed patients – evaluate for mother's medications as they can cause toxicity in the infant.
- Pediatric pacer pads should be used if available. If only adult pads are obtainable – they should be placed in the anterior-posterior position.

TACHYCARDIA w/PULSE

Signs and Symptoms:
- **Ventricular Tachycardia on EKG (rate typically ≥150/min)**
- **Conscious, Rapid Pulse**
- **Chest Pain / Shortness of Breath**
- **Palpitations**
- **Dizziness**
- **Anxiety**

Differential Diagnosis (*Wide Complex QRS >.12sec*):
- **Artifact / Device Failure**
- **Cardiac**
- **Endocrine / Metabolic**
- **Hyperkalemia**
- **Drugs**
- **Pulmonary**

Differential Diagnosis (*Narrow QRS*):
- **Wolf-Parkinson-White Syndrome**
- **Valvular Heart Disease**
- **Sick Sinus Syndrome**
- **Myocardial Infarction**
- **Electrolyte Imbalance**
- **Sinus Tachycardia / Atrial Flutter**
- **Hypoxia**
- **Drug Overdose / Toxin**
- **Hyperthyroidism**

Universal Patient Care Guideline
O_2 (if Hypoxemic)
IV / IO Guideline
Monitor and 12-lead ECG (ASAP)

METOPROLOL
5mg IV q5min X 3
Hold if SBP <100, P <60

DILTIAZEM
20mg (0.25mg/kg) IV over 2min. If no hypotension, after 15 min repeat at 25mg (0.35mg/kg)

ADENOSINE
- 1st Dose: 6mg rapid IV push: followed by NS Flush
- 2nd Dose: 12mg

Chest Pain / SOB / Dizziness?
- YES → **Chest Pain Guideline**
- NO → **Observe Reassess q 5 minutes**

"Sinus Tach"
- YES → **STABLE**
- NO → **QRS Width?** No unstable signs / symptoms, No "Sinus Tach"

STABLE
- NO → **UNSTABLE: Signs / Symptoms of:**
  - BP Low (hypotension)
  - Altered mental status
  - Signs/symptoms of shock
  - Ischemic chest pain
  - Congestive heart failure (acute)

***Synchronized Cardioversion:**
- Narrow Irregular, A-Fib
- Narrow Regular, SVT, Atrial Flutter
- Wide Regular, Stable Monomorphic VT

Consider Sedation: Midazolam 2-5mg IV / IO

QRS Width? No unstable signs / symptoms, No "Sinus Tach"

Narrow QRS? ≤0.12 Second
- Regular → **Vagal Maneuvers:** Blow through 18ga IV catheter, carotid massage, bear down.
  - **ADENOSINE: use for Regular Rhythm ONLY!**
  - **DILTIAZEM**
  - **METOPROLOL**
- Irregular → **DILTIAZEM**, **METOPROLOL**

***Synchronized Cardioversion:**
- Narrow Irregular, A-Fib
- Narrow Regular, SVT, Atrial Flutter

Consider Sedation: Midazolam 2-5mg IV / IO

Wide QRS? >0.12 Second
- Regular → Consider:
  - **AMIODARONE**

If refractory or becomes unstable at any time!

AMIODARONE
Stable Wide-QRS Tachy
- 1st Dose: 150mg IV over 10min
- Repeat prn if VT recurs
- Maintenance infusion: 1mg/min for 1st 6 hrs

- Irregular → Consider:
  - **Torsades
  - A-Fib with/or Wolff-Parkinson-White (look for a delta wave)
  - Procainamide 20-50mg/min until arrhythmia suppression, hypotension, QRS widens by >50%, or total dose 17mg/kg reached

All Pathways End with Continuous Monitoring

Pearls:
- ****Torsades de Pointes** may Benefit from early use of **Magnesium**: 1-2 grams IV over 60 min (Mix in 50ml D5W) Start drip of 0.5-1 gram/hr and titrate to effect.
- If hyperkalemia suspected (end-stage renal disease, dialysis) – administer Ca Chloride through central access or Ca Gluconate through peripheral IV.
- All patients should be warned of discomfort / feeling of heart stopping prior to adenosine administration.

***Synchronized Cardioversion**
(Increase Js per manufacture's recommendation)

Narrow Irregular, Atrial Fibrillation:
- 120-200 J biphasic

Narrow Regular, Other SVT, Atrial Flutter:
- 50-100 J, increase in stepwise fashion

Wide Regular, Stable Monomorphic VT:
- 100 J, increase in stepwise fashion

Wide Irregular:
- Defibrillate (NOT Synchronized)
- Go to: **Cardiac Arrest Guideline**

PEDIATRIC TACHYCARDIA with Pulse and Adequate Perfusion

Typical HR/min

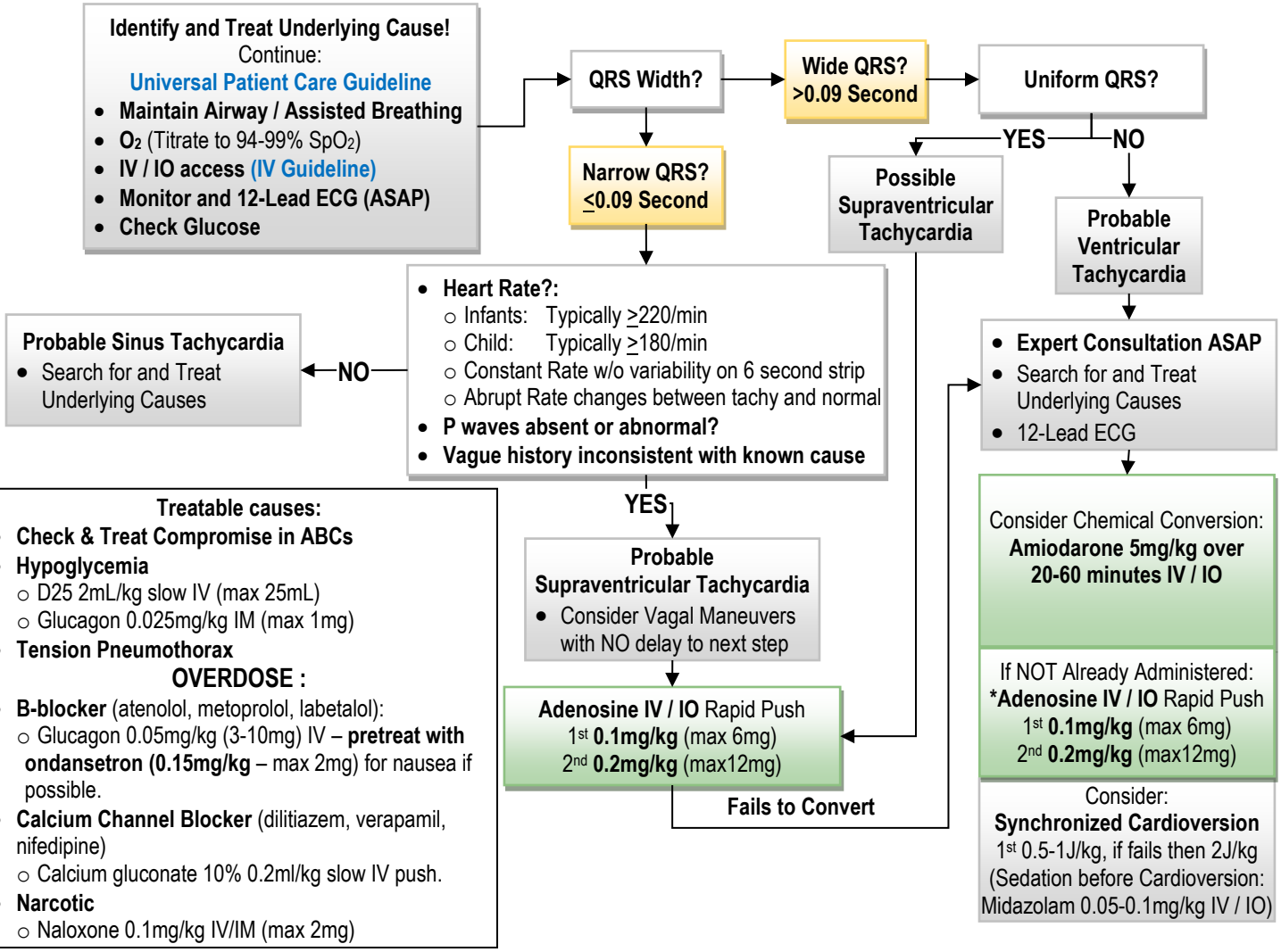
- Newborn 85 - 205
- 3mth – 2y/o 100 - 190
- 2y/o to 10y/o 60 -140
- >10y/o 60 - 100

Typical Sinus Tachycardia Rates

- **Infants <220/min**
- **Children <180/min**

Indicators of CARDIOPULMONARY COMPROMISE

- **Hypotension**
  - 1-10 y/o lower limit = 70+(years old x 2)mmHg
  - >10 y/o lower limit = 90mmHg
- **Acutely Altered Mental Status**
  - GCS <8, Weak Cry, Unusual Irritability, Altered Responsiveness, Lethargy, or Failure to Respond to Painful Stimulus
- **Signs of Shock**


Identify and Treat Underlying Cause!
Continue:
Universal Patient Care Guideline
Maintain Airway / Assisted Breathing
O2 (Titrate to 94-99% SpO2)
IV / IO access (IV Guideline)
Monitor and 12-Lead ECG (ASAP)
Check Glucose
QRS Width?
Wide QRS? >0.09 Second
Uniform QRS?
YES
NO
Narrow QRS? ≤0.09 Second
Possible Supraventricular Tachycardia
Probable Ventricular Tachycardia
Heart Rate?:
Infants: Typically ≥220/min
Child: Typically ≥180/min
Constant Rate w/o variability on 6 second strip
Abrupt Rate changes between tachy and normal
P waves absent or abnormal?
Vague history inconsistent with known cause
NO
Probable Sinus Tachycardia
Search for and Treat Underlying Causes
YES
Probable Supraventricular Tachycardia
Consider Vagal Maneuvers with NO delay to next step
Adenosine IV / IO Rapid Push
1st 0.1mg/kg (max 6mg)
2nd 0.2mg/kg (max12mg)
Fails to Convert
Expert Consultation ASAP
Search for and Treat Underlying Causes
12-Lead ECG
Consider Chemical Conversion:
Amiodarone 5mg/kg over 20-60 minutes IV / IO
If NOT Already Administered:
*Adenosine IV / IO Rapid Push
1st 0.1mg/kg (max 6mg)
2nd 0.2mg/kg (max12mg)
Consider:
Synchronized Cardioversion
1st 0.5-1J/kg, if fails then 2J/kg
(Sedation before Cardioversion: Midazolam 0.05-0.1mg/kg IV / IO)

Treatable causes:

- **Check & Treat Compromise in ABCs**
- **Hypoglycemia**
  - D25 2mL/kg slow IV (max 25mL)
  - Glucagon 0.025mg/kg IM (max 1mg)
- **Tension Pneumothorax**

OVERDOSE :

- **B-blocker** (atenolol, metoprolol, labetalol):
  - Glucagon 0.05mg/kg (3-10mg) IV – **pretreat with ondansetron (0.15mg/kg** – max 2mg) for nausea if possible.
- **Calcium Channel Blocker** (dilitiazem, verapamil, nifedipine)
  - Calcium gluconate 10% 0.2ml/kg slow IV push.
- **Narcotic**
  - Naloxone 0.1mg/kg IV/IM (max 2mg)

Pearls:

- **Vagal maneuvers:** blow through 18ga IV catheter, ice pack on forehead, carotid massage (unilateral only – listen for bruits prior to performing), or having patient blow against closed glottis ("bear down").
- ***Adenosine should be as central as possible with the "2 syringe technique" – one with adenosine and the other with the saline flush. These should be attached to a 2 port IV adapter and flush should immediately follow drug.**
- ***Adenosine should be utilized in <u>monomorphic and regular R-R interval</u> type presentation.**
- All patients should be warned of discomfort / feeling of heart stopping before adenosine administration.

PEDIATRIC TACHYCARDIA with Pulse and Poor Perfusion

Typical HR/min

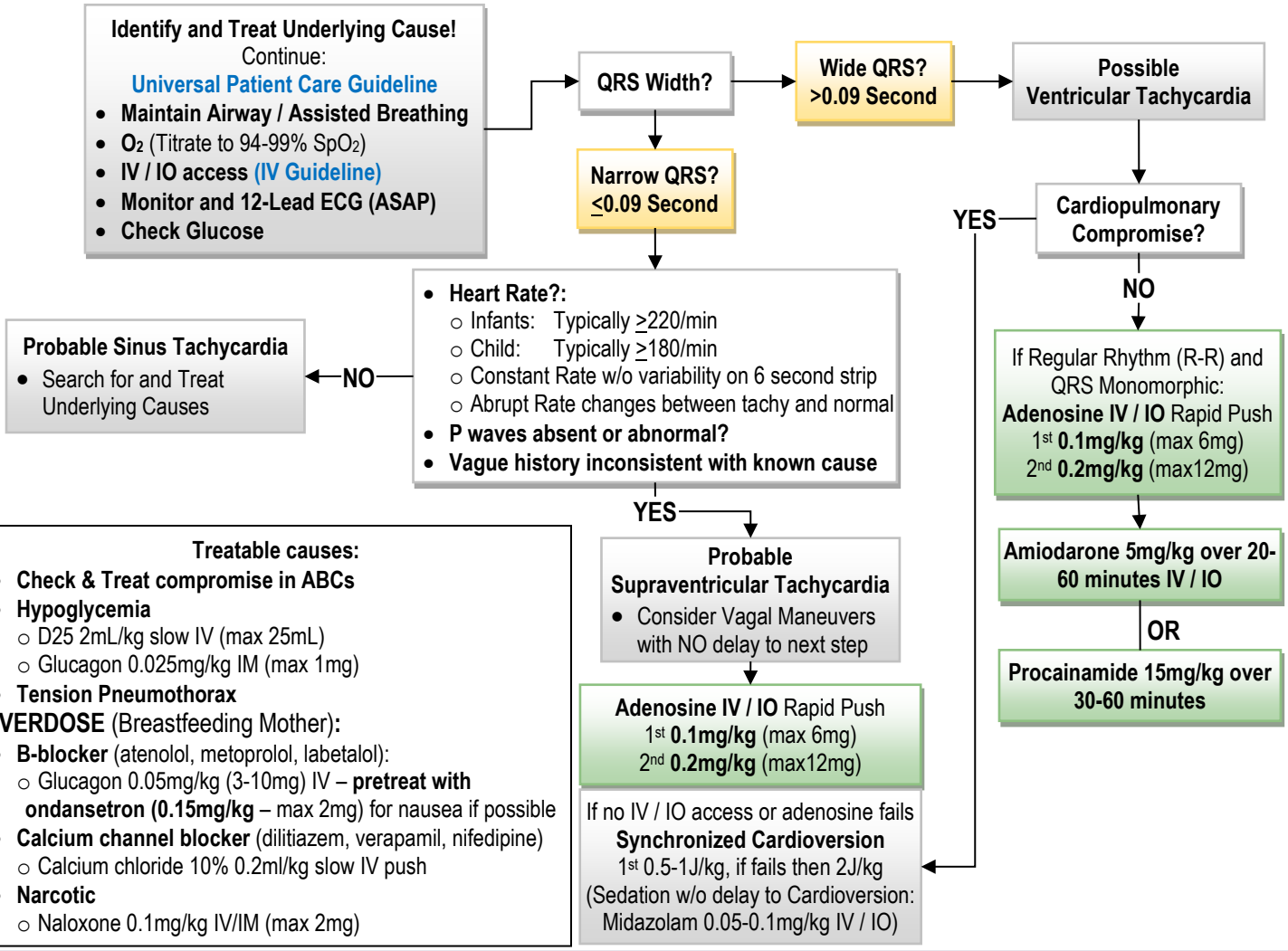
- Newborn 85 - 205
- 3mth – 2y/o 100 - 190
- 2y/o to 10y/o 60 -140
- >10 y/o 60 - 100

Typical Sinus Tachycardia Rates

- **Infants < 220/min**
- **Children <180/min**

Indicators of CARDIOPULMONARY COMPROMISE

- **Hypotension**
  - 1-10 y/o lower limit = 70+(years old X 2)mmHg
  - > 10 y/o lower limit = 90mmHg
- **Acutely Altered Mental Status**
  - GCS <8, Weak Cry, Unusual Irritability, Altered Responsiveness, Lethargy, or Failure to respond to painful stimulus
- **Signs of Shock**


Identify and Treat Underlying Cause!
Continue:
Universal Patient Care Guideline
Maintain Airway / Assisted Breathing
O2 (Titrate to 94-99% SpO2)
IV / IO access (IV Guideline)
Monitor and 12-Lead ECG (ASAP)
Check Glucose
QRS Width?
Wide QRS? >0.09 Second
Possible Ventricular Tachycardia
Narrow QRS? ≤0.09 Second
Cardiopulmonary Compromise?
YES
NO
Heart Rate?:
Infants: Typically ≥220/min
Child: Typically ≥180/min
Constant Rate w/o variability on 6 second strip
Abrupt Rate changes between tachy and normal
P waves absent or abnormal?
Vague history inconsistent with known cause
Probable Sinus Tachycardia
Search for and Treat Underlying Causes
NO
YES
If Regular Rhythm (R-R) and QRS Monomorphic:
Adenosine IV / IO Rapid Push
1st 0.1mg/kg (max 6mg)
2nd 0.2mg/kg (max12mg)
Amiodarone 5mg/kg over 20-60 minutes IV / IO
OR
Procainamide 15mg/kg over 30-60 minutes
Probable Supraventricular Tachycardia
Consider Vagal Maneuvers with NO delay to next step
Adenosine IV / IO Rapid Push
1st 0.1mg/kg (max 6mg)
2nd 0.2mg/kg (max12mg)
If no IV / IO access or adenosine fails
Synchronized Cardioversion
1st 0.5-1J/kg, if fails then 2J/kg
(Sedation w/o delay to Cardioversion: Midazolam 0.05-0.1mg/kg IV / IO)

Treatable causes:

- **Check & Treat compromise in ABCs**
- **Hypoglycemia**
  - D25 2mL/kg slow IV (max 25mL)
  - Glucagon 0.025mg/kg IM (max 1mg)
- **Tension Pneumothorax**

OVERDOSE (Breastfeeding Mother)**:**

- **B-blocker** (atenolol, metoprolol, labetalol):
  - Glucagon 0.05mg/kg (3-10mg) IV – **pretreat with ondansetron (0.15mg/kg** – max 2mg) for nausea if possible
- **Calcium channel blocker** (dilitiazem, verapamil, nifedipine)
  - Calcium chloride 10% 0.2ml/kg slow IV push
- **Narcotic**
  - Naloxone 0.1mg/kg IV/IM (max 2mg)

Pearls:

- **Vagal maneuvers:** blow through 18ga IV catheter, ice pack on forehead, carotid massage (unilateral only – listen for bruits prior to performing), or having patient blow against closed glottis ("bear down").
- **Adenosine should be given with the "2 syringe technique" – one with adenosine and the other with the saline flush. These should be attached to a 2 port IV adapter and flush should immediately follow drug.**
  - All patients should be warned of discomfort / feeling of heart stopping before adenosine administration.

POST-CARDIAC ARREST CARE

Signs and Symptoms:
- **Return of Spontaneous Circulation**
- **Pulse**
- **Respirations**

Differential Diagnosis:
- **Continually Address Primary Pathology Associated with Arrest**

Universal Patient Care Guideline

Continuous Monitoring and Maintain:
- **Circulation:** Palpable Pulses and BP
- **O_2:** Sat < 90% (may need advanced airway)
- **12 lead ECG / Defibrillator**
- **IV / IO access** (IV Guideline)

Consider as appropriate: **Post-Resuscitation Induced Hypothermia Guideline**

Hypotension (SBP <90 mm Hg)

Fluid bolus ***See pearls Reperfusion** and **Trauma Patients**

For Refractory Hypotension Consider:
Norepinephrine
0.1-0.5 mcg/kg/mil
Epinephrine
2-10 mcg/min

Consider Treatable Causes

Move to appropriate Cardiac guideline (opposite side of page) based on changes in Pulse and ECG.

Changes in Pulses or Significant Ectopy

Loss of Pulses, or onset of VF / pulseless VT, asystole / PEA: Move to **Cardiac Arrest Guideline**

Symptomatic Bradycardia move to **Bradycardia with Pulse Guideline**

Symptomatic Tachycardia, Pulse >150/min move to **Tachycardia with Pulse Guideline**

Reversible Causes:
- **Hypovolemia**
- **Hypoxia**
- **Hydrogen ion (acidosis)**
- **Hypo-hyperkalemia**
- **Hypothermia**
- **Hypo-Hyperglycemia**
- **Tension pneumothorax**
- **Tablets/toxin**
- **Tamponade, cardiac**
- **Thrombus – cardiac**
- **Thrombus – pulmonary**

Pearls:
- Hyperventilation may cause hypotension and/or recurrence of cardiac arrest in the post-resuscitation phase and must be avoided.
- Most patients will require ventilator assistance in the post-resuscitative phase.
- In non-airway controlled patients, it is important to prevent aspiration following resuscitation. For this reason, patients should be rotated onto their side (non-spinal immobilization) or be closely monitored in case vomiting occurs.
- ***Reperfusion:** 1-2 L IVF and consider use of a pressor IV / IO **Drip** – **EPINEPHRINE 2-10mcg/min** or **NOREPINEPHRINE 0.1-0.5 mcg/kg/min: 70kg adult: 7-35mcg/min**.
  - **Dopamine should be started at a low dose (5mcg/kg/min)** and titrated up to maintain a SBP >90. The same applies norepinephrine.
- ***Trauma patients** post-resuscitation should have fluid resuscitation consistent with hypotensive resuscitation guidelines. Maintain body core temperature 32-36 degrees Celsius for at least 24 hours.

HYPERTENSION

Signs and Symptoms of ***Hypertensive Crisis w/ end organ damage.***

One of These:

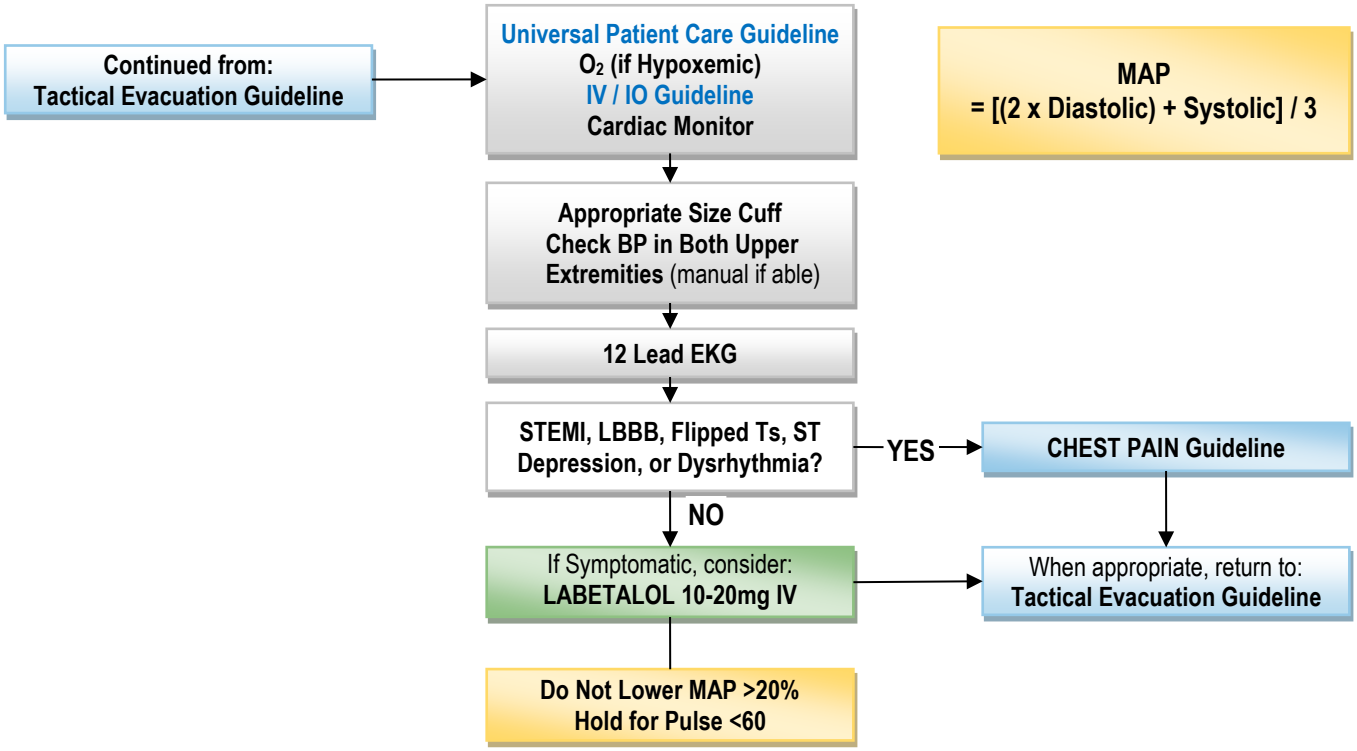
- **Systolic BP 185+**
- **Diastolic BP 110+**

Plus One of These:

- **Altered Mental Status**
- **Blurred Vision**
- **Dizziness / Stroke Symptoms**
- **Chest Pain**

Differential Diagnosis:

- **Primary CNS injury (Cushing's Reflex)**
- **Myocardial Infarction**
- **Aortic Dissection**
- **Pre-Eclampsia / Eclampsia**
- **Toxin / Medication**



Pearls:

- Do not treat elevated blood pressure based on one set of vital signs.
- Improper cuff size and equipment malfunction are common reasons for abnormally high readings.
- If patient has none of the above symptoms of hypertensive emergencies – they do not require treatment of their blood pressure.
- In setting of stroke – do not treat blood pressure unless SBP >220 and/or DBP >120 or signs of end-organ involvement.
  - Elevated BP is required to maintain perfusion during a stroke.
- Only lower MAP approximately 20% with slow, titrated doses – hypertensive patients often need elevated BP to maintain organ / CNS perfusion. MAP = [(2 x Diastolic) + Systolic] / 3
- **Labetalol is contraindicated in patients with severe asthma / COPD. In these patients, NTG can be given to lower BP if absolutely necessary. Labetalol doses above are for symptomatic hypertension patients, not hypertension alone.**
- **Metoprolol is contraindicated for CHF, Acute PE, bronchospasms, bradycardia, hypotension, hx of asthma, and thyrotoxicosis.**

ALTITUDE ILLNESS

Differential Diagnosis:
- **Head Trauma**
- **Stroke**
- **CNS Tumor / Mass / Bleed / Infection**
- **Endocrine Disorder**
- **Toxic Ingestion**
- **Pneumonia / PE**
- **Cephalgia**

Acute Mountain Sickness (AMS)	High Altitude Cerebral Edema (HACE)	High Altitude Pulmonary Edema (HAPE)
• Headache • Nausea / Vomiting • Lethargy • Dizziness	• AMS Symptoms • Unstable Gait • Drowsiness • Confusion • Coma	• Cough • Dyspnea • Pink Frothy Sputum • Cyanosis • Hyperthermia

Continued from: Tactical Evacuation Guideline

Universal Patient Care Guideline
O_2 (ASAP)
IV / IO Guideline
Cardiac Monitor (ASAP)

Hypothermia Precautions
Hypothermia Guideline

Immediate / 1st Line Care for any form of Altitude Illness:
- **Rapid Descent (as mission able)**
- **O_2**
- **Gamow Bag (when descent is not possible)**

Symptoms

Headache
→ **Altered Mental Status or Ataxia?**
→ YES (HACE) → **Rapid Descent** Consider: **Gamow Bag (*See Pearls)**
→ **O_2** (If not previously started)
→ **Dexamethasone: Initial Loading dose 10mg IV / IO** (6mg if 4mg already provided) (then 4mg IV / IO / PO q6hr)
→ **Ondansetron 4-8mg IV / IO**
→ Consider:
- **Acetaminophen 650-1000mg PO**
- **Ibuprofen 600-800mg PO**

NO (AMS) → **Prevent Further Ascent**
→ **O_2** (If not previously started)
→ **Descend 500-1000m if able**
→ **Acetazolamide 125-250mg PO**
→ **Dexamethasone 4mg IV / IO / PO q6hr**
→ **Altered Mental Status**
→ YES → **Rapid Descent** Consider: **Gamow Bag (*See Pearls)**
→ NO → Consider: **Acetaminophen 650-1000mg PO**, **Ibuprofen 600-800mg PO**

Pulmonary Symptoms (HAPE)
→ **Rapid Descent** Consider: **Gamow Bag (*See Pearls)**
→ **O_2** (If not previously started)
→ **Nifedipine 10mg PO q4-6hr**
→ Consider: **Assisted Ventilation (PPV)**
→ **Altered Mental Status or Ataxia?**
→ YES → **Dexamethasone: Initial Loading dose 10mg IV / IO** (6mg if 4mg already provided) (then 4mg IV / IO / PO q6hr)
→ NO → Consider: **Acetaminophen 650-1000mg PO**, **Ibuprofen 600-800mg PO**

When appropriate, return to: **Tactical Evacuation Guideline**

Pearls:
- **The treatment of choice for all altitude-related illnesses is supplemental O_2 and descent** – at least 500-1000m. If unable to descend, a hyperbaric bag (Gamow bag) can be utilized if available.
  - If unable to descend immediately - as soon as HACE or HAPE are suspected, the crew must begin engaging actively with the PIC or other tactical commander to work the issue of descent ASAP.
- **Acetazolamide should not be given to those patients with Sulfa allergies or known Sickle Cell Anemia**.
- **High-Altitude Pulmonary Edema (HAPE)** patients may have crackles / fever / hypoxia.
- **High-Altitude Cerebral Edema (HACE)** patients have AMS and may have tremors, HACE often occurs along with HAPE.
  - ANY altered mental status / confusion / abnormal gait should be presumed to have cerebral edema and descent should be undertaken immediately.
- *Descent should be done with the least amount of patient exertion possible to prevent worsening of the condition.

Animal and Insect Bites and Stings

Signs and Symptoms:

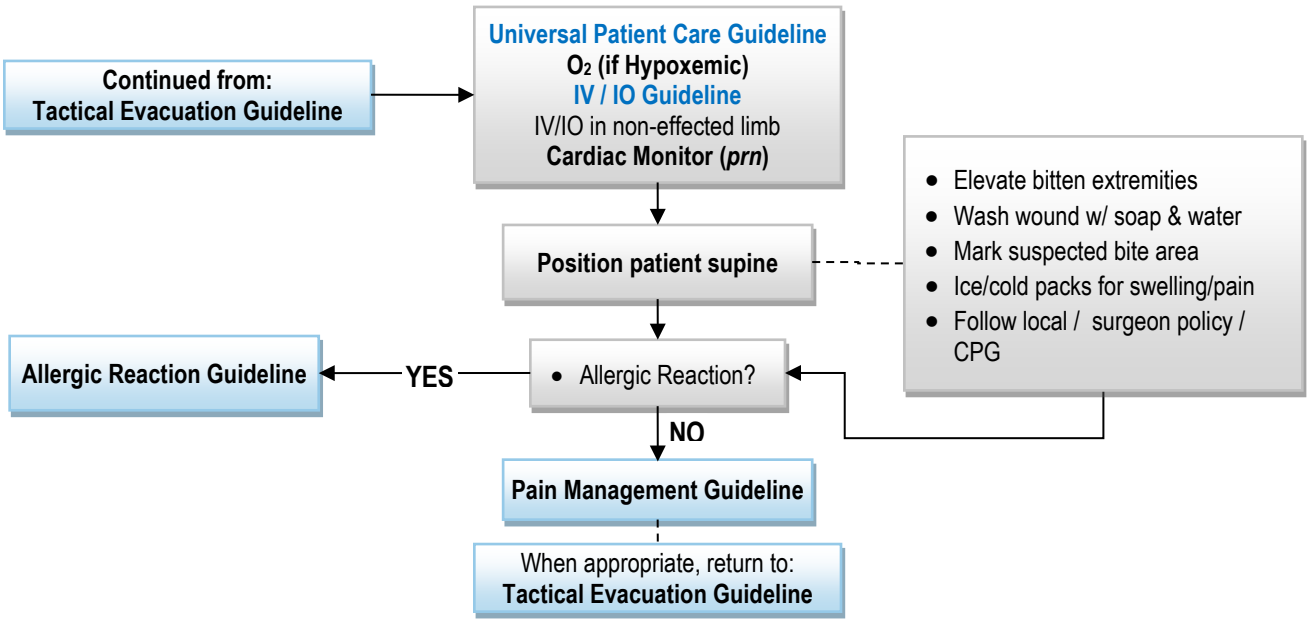
- **Rash, Skin Break, Wound, Retained Stinger**
- **Pain, Swelling, Erythema**
- **Bleeding / Discharge**
- **Shortness of Breath / Wheezing / Throat Tightness**
- **Hypotension or Shock**

Differential Diagnosis:

- **Bite / Envenomation**
- **Other Allergic Reaction**
- **Anaphylaxis**
- **Rabies / Tetanus Risk**

For SPIDER / SCORPION see: **SPIDER and SCOPRION Envenomation**

For SNAKEBITE see: **Snakebite Envenomation**

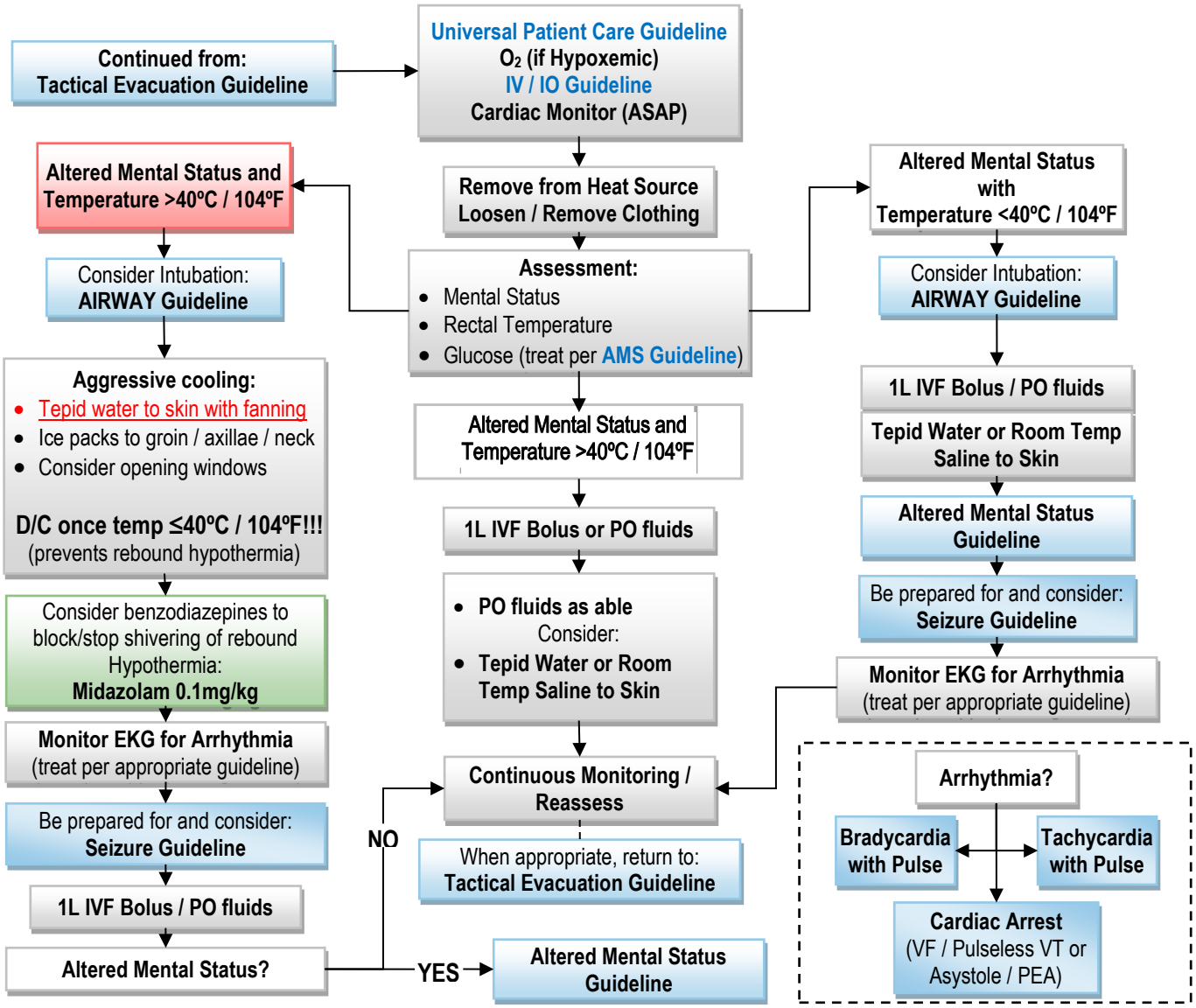


Pearls:

- Never attempt to capture / transport a live animal / insect.
- **Anaphylactic reactions should be treated as soon as recognized.**
- Review country environmental concerns before deployment or visitation.
- All animals should be considered rabid outside the U.S. until proven otherwise. This excludes rodents, which do not carry rabies.
- Consider IV administration of Calcium Gluconate if Tetany develops.
- Elevate effected limb to reduce swelling
- ***DO NOT apply constricting bandages or tourniquets*** as these may worsen local tissue injury and increase the risk of permanent disability.
- ***DO NOT*** cut, suck, electrocute, burn, or use chemicals on the envenomation site

HYPERTHERMIA

Signs and Symptoms:	Differential Diagnosis:	
• Altered Mental Status • Loss of Consciousness • Hot / Dry or Sweaty Skin • Hypotension or Shock • Seizure • Nausea / Vomiting	• Infection • Dehydration • Thyroid Storm • Medications / Toxin • Delirium Tremens • Heat Cramps	• Heat Exhaustion • Heat Stroke • CNS Lesions or Tumors


Continued from: Tactical Evacuation Guideline
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)
Remove from Heat Source
Loosen / Remove Clothing
Assessment:
Mental Status
Rectal Temperature
Glucose (treat per AMS Guideline)
Altered Mental Status and Temperature >40ºC / 104ºF
Consider Intubation: AIRWAY Guideline
Aggressive cooling:
Tepid water to skin with fanning
Ice packs to groin / axillae / neck
Consider opening windows
D/C once temp ≤40ºC / 104ºF!!!
(prevents rebound hypothermia)
Consider benzodiazepines to block/stop shivering of rebound Hypothermia:
Midazolam 0.1mg/kg
Monitor EKG for Arrhythmia
(treat per appropriate guideline)
Be prepared for and consider:
Seizure Guideline
1L IVF Bolus / PO fluids
Altered Mental Status?
NO
YES
1L IVF Bolus or PO fluids
PO fluids as able
Consider:
Tepid Water or Room Temp Saline to Skin
Continuous Monitoring / Reassess
When appropriate, return to:
Tactical Evacuation Guideline
Altered Mental Status Guideline
Altered Mental Status with Temperature <40ºC / 104ºF
Consider Intubation: AIRWAY Guideline
1L IVF Bolus / PO fluids
Tepid Water or Room Temp Saline to Skin
Altered Mental Status Guideline
Be prepared for and consider:
Seizure Guideline
Monitor EKG for Arrhythmia
(treat per appropriate guideline)
Arrhythmia?
Bradycardia with Pulse
Tachycardia with Pulse
Cardiac Arrest
(VF / Pulseless VT or Asystole / PEA)

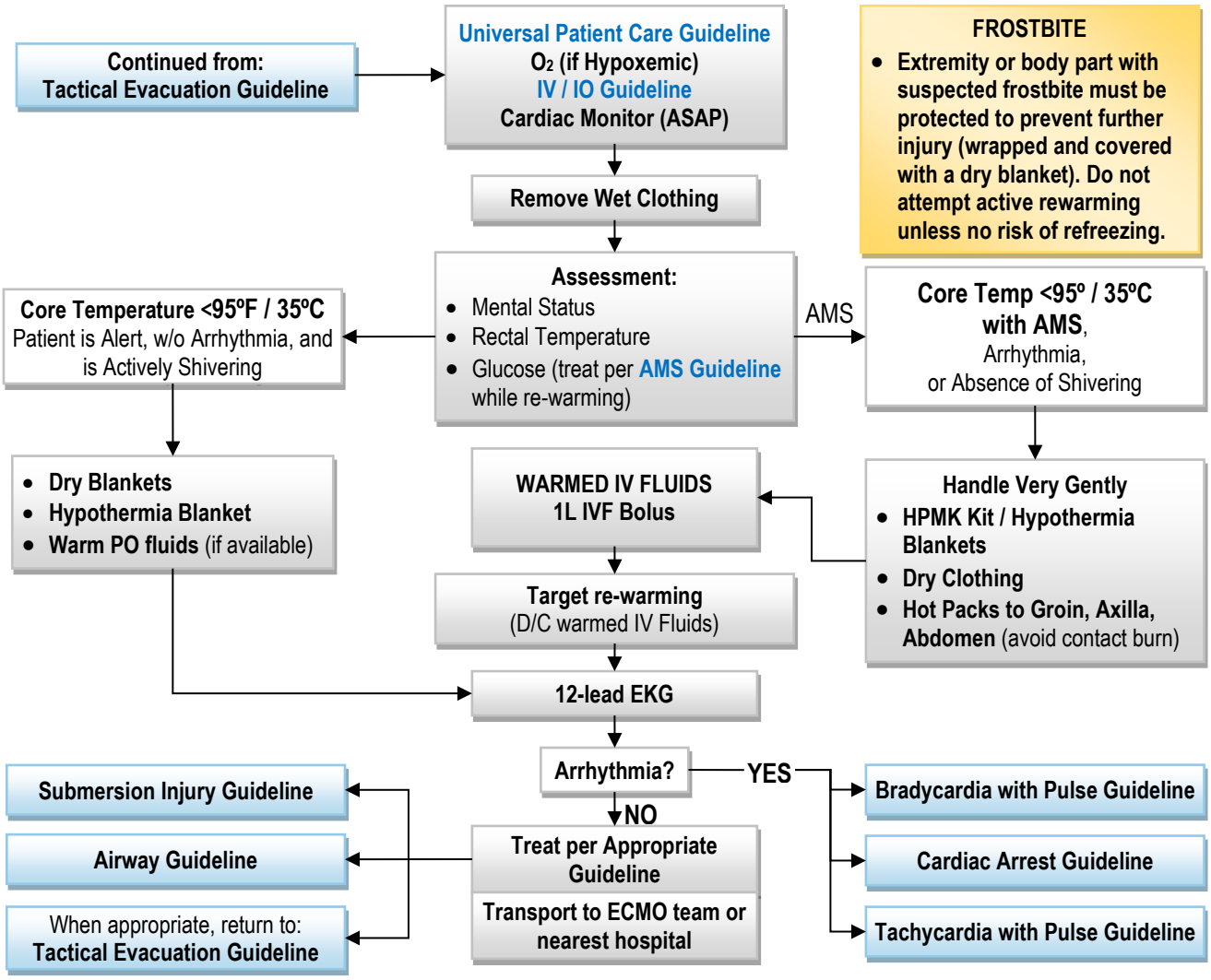
Pearls:

- The single best method to cool patient is sublimation-sprinkling with water and fanning to evaporate off the skin
- Groups at elevated risk for heat emergencies: elderly, very young, highly active.
- Use of alcohol, cyclic antidepressants, phenothiazines, and anticholinergic medications increase risk.
- Cocaine, ecstasy, amphetamines, and aspirin toxicity can all raise body temperature.
- Sweating does not exclude heat stroke / heat illness.
- In conscious patients that can protect their airway, encourage intake of PO fluids and electrolytes.

HYPOTHERMIA

Signs and Symptoms:
- Cold, Clammy
- Shivering / Lack of Shivering
- Mental Status Changes
- Extremity Pain / Numbness
- Bradycardia / Arrhythmia
- Hypotension or Shock

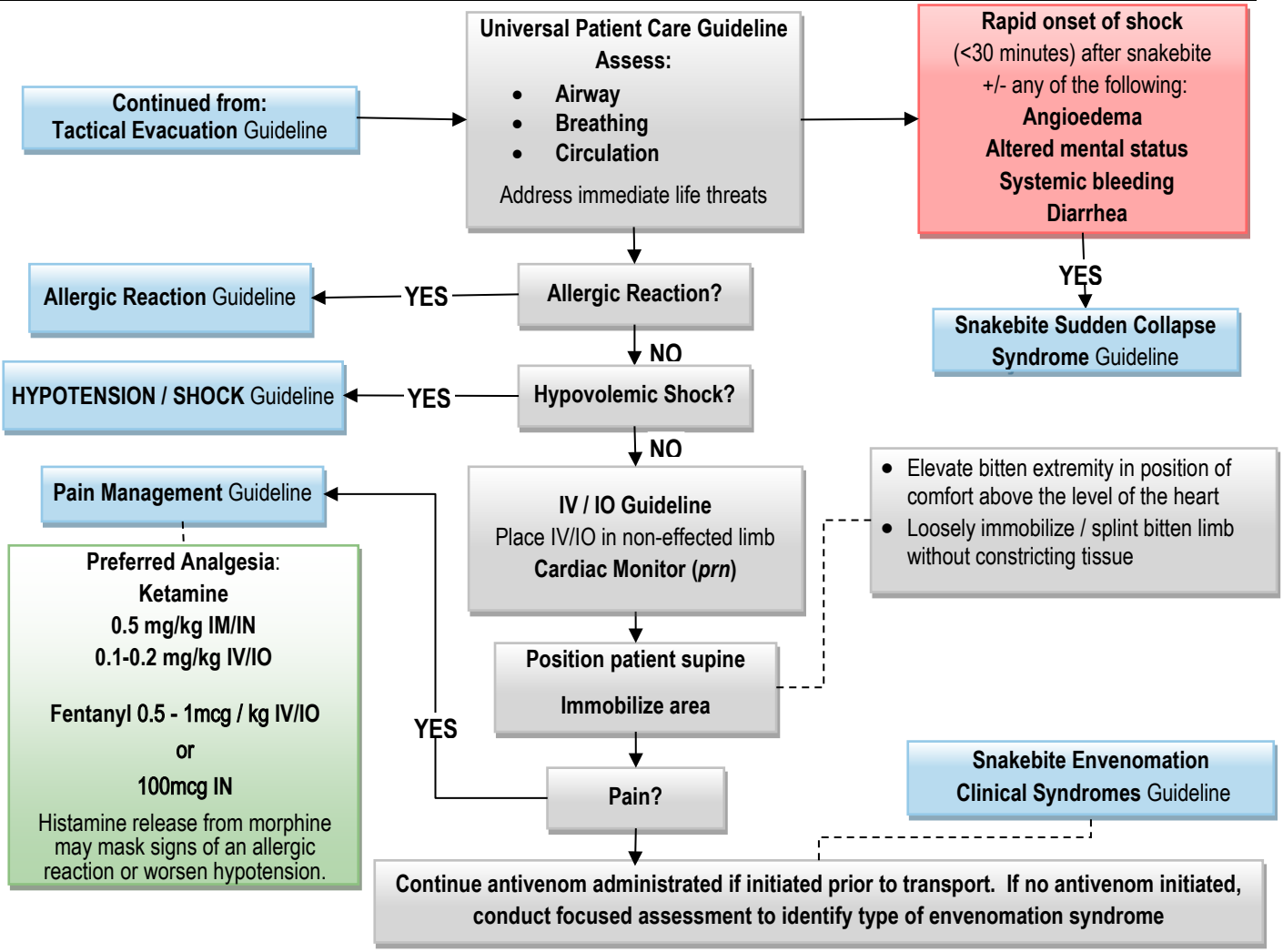
Differential Diagnosis:
- Sepsis
- Environmental Exposure
- Hypoglycemia
- CNS Dysfunction
- Toxic Ingestion


Continued from: Tactical Evacuation Guideline
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline
Cardiac Monitor (ASAP)
FROSTBITE
Extremity or body part with suspected frostbite must be protected to prevent further injury (wrapped and covered with a dry blanket). Do not attempt active rewarming unless no risk of refreezing.
Remove Wet Clothing
Assessment:
Mental Status
Rectal Temperature
Glucose (treat per AMS Guideline while re-warming)
Core Temperature <95ºF / 35ºC
Patient is Alert, w/o Arrhythmia, and is Actively Shivering
AMS
Core Temp <95º / 35ºC with AMS, Arrhythmia, or Absence of Shivering
Dry Blankets
Hypothermia Blanket
Warm PO fluids (if available)
WARMED IV FLUIDS
1L IVF Bolus
Handle Very Gently
HPMK Kit / Hypothermia Blankets
Dry Clothing
Hot Packs to Groin, Axilla, Abdomen (avoid contact burn)
Target re-warming
(D/C warmed IV Fluids)
12-lead EKG
Arrhythmia?
YES
NO
Submersion Injury Guideline
Airway Guideline
When appropriate, return to: Tactical Evacuation Guideline
Treat per Appropriate Guideline
Transport to ECMO team or nearest hospital
Bradycardia with Pulse Guideline
Cardiac Arrest Guideline
Tachycardia with Pulse Guideline

Pearls:
- "No patient is dead until they are warm and dead."
- Hypothermia defined as core temperature <95ºF (35ºC).
- With temperatures <31ºC (88ºF) ventricular fibrillation is common. Cardiac muscle becomes very irritable as temperature drops and rough handling may induce a cardiac dysrhythmia.
- With temperatures below 30ºC (86ºF) shivering ceases – removing an important heat production source.
- The pulse may be very slow in hypothermic patients – should wait at least one minute to feel pulse.
- Arrhythmias at temperature >30ºC (86ºF) treated similar to normo-thermic patients with the addition of active re-warming.
- At temperatures <30ºC (86ºF) one defibrillation can be attempted, but withhold further attempts / meds until temp >30ºC (86ºF).

Snake Envenomation Management: General Principles

If the patient is being medically evacuated from the field or between roles of care, confirm that the receiving facility has an adequate supply of the appropriate regionally specific antivenoms. *Evacuation is not an alternative to antivenom administration. A patient whose snakebite warrants evacuation will require antivenom. The earlier it is given the greater the chance of full recovery without permanent disability.* ***DO NOT*** *delay administration of antivenom in the field if available to a patient with an envenomation.*

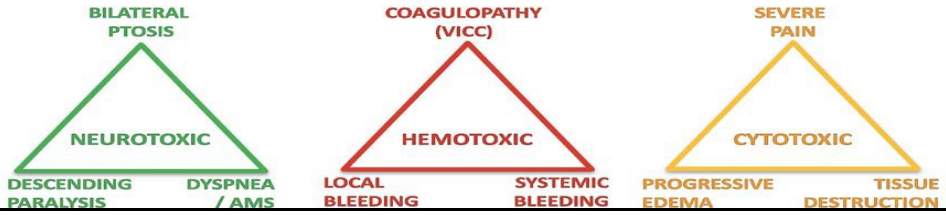


Pearls:

- ***Don't try to ID the snake.*** Snake identification is unreliable and should not be purposely attempted.
- ***DO NOT*** attempt to catch or kill the snake; treatment is clinical and the snake species does not need to be identified. Never attempt to capture or transport a live snake
- Amount of envenomation from snake bites can be variable or dry bites" Snakebite treatment should always be determined by the clinical presentation and evolution of signs and symptoms in the patient
- ***DO NOT*** use ice / tourniquets or constricting bandages as these may worsen local tissue injury and increase the risk of permanent disability.
- If a tourniquet is already in place, ***do not*** remove it until you are ready to treat and resuscitate the patient as a rapid decompensation can occur
- Anaphylactic reactions or hypovolemic shock should be treated as soon as recognized.
- Snakebites are clinically dynamic emergencies and can change dramatically until control has been achieved.

Snakebite Envenomation Clinical Syndromes

There are 3 major clinical syndromes of snakebite envenomation worldwide and 3 major signs and symptoms of each. All dangerous snakes capable of injuring or killing a human will produce at least one sign or symptom from at least one of the 3 major snakebite syndromes. Specific antivenoms required will vary regionally but the major triads are applicable globally.



Continued from:
Snake Envenomation Management: General Principles

Conduct Focused Assessment and Examination to Identify Envenomation Syndrome

With permanent marker:

- Write time of bite on patient
- Circle bite mark on patient

Conduct rapid examination for signs of:

- **Pain**
- **Swelling (edema)**
- **Tissues destruction (necrosis)**

YES → **CYTOTOXIC SYNDROME:**

- Mark leading edge of pain with a dash line (- - -) and annotate time
- Mark leading edge of edema with a solid line and annotate time

It is important to keep the limb significantly elevated (> 60° is ideal) whenever possible to limit dependent edema and swelling.

NO

Rapid examination for signs of local or systemic bleeding:

- persistent local bleeding > 30 mins from the bite wound (if visible) or other lesions
- Inspect the molar gingiva and other mucosa for signs of systemic bleeding

YES → **HEMOTOXIC SYNDROME:**

- Internal and external active bleeding should cease within 30 – 60 minutes of antivenom administration once the appropriate dose has been given.
- Packed red blood cell or whole blood transfusion can be considered if the patient is in hemorrhagic shock
- Platelets, fresh frozen plasma, cryoprecipitate, TXA, and ***other agents are not effective in these cases*** due to the mechanism of the venoms.

NO

Rapid examination for signs of neuromuscular weakness:

- Evaluate respiratory muscle weakness by single breath count testing
- Dyspnea?.
- Signs and symptoms of descending flaccid paralysis: Ptosis, diplopia, neck flexor muscle weakness, bulbar weakness, etc.
- Signs and symptoms of parasympathetic / cholinergic crisis: SLUDGE mnemonic - Salivation, Lacrimation, Urination, Defecation, GI distress, Emesis
- Altered Mental Status?

YES → **NUEROTOXIC SYNDROME:**

Anticipate the need for aggressive airway management with intubation and prolonged ventilation in all patients presenting with neurotoxic envenomation.

Cholinergic Crisis? → **Consider:**
Atropine 0.5mg IV/IO

- Titrated by auscultation to dry up bronchial and oral hypersecretions

Pediatric Dose:
0.01mg/kg up to .25mg

Refer to JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG) Global Snake Envenomation Management (CPG ID: 81) for 1st and 2nd line ANTIVENOM based on Region and Syndrome. Follow JTS CPG for ANTIVENOM administrations.

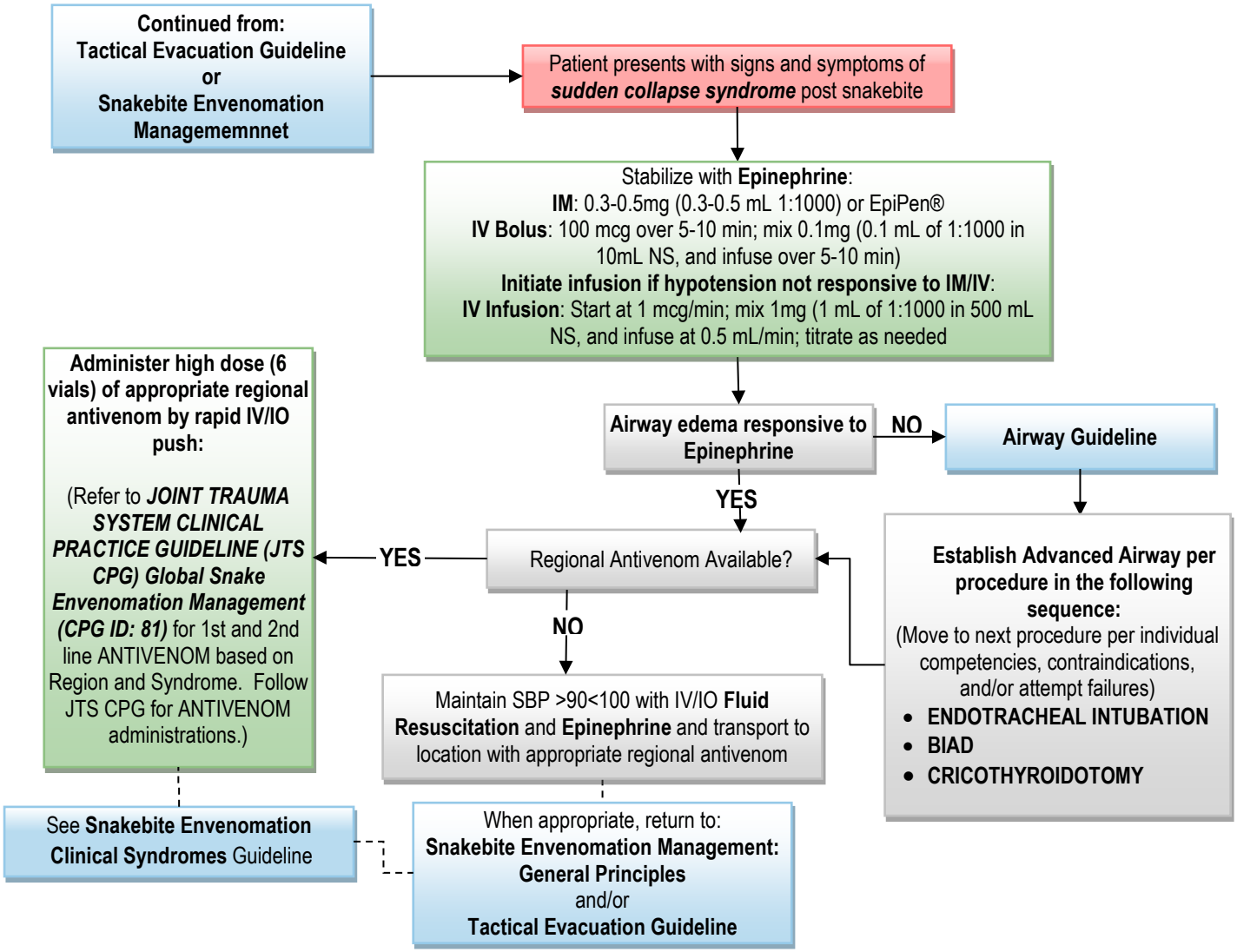
SNAKEBITE SUDDEN COLLAPSE SYNDROME

Signs and Symptoms:

- **Rapid onset of Shock (<30 min) from bite with any of the following:**
  - **Angioedema**
  - **Altered Mental Status**
  - **Systemic Bleeding**
  - **Diarrhea**

Differential Diagnosis:

- **Neurotoxic Syndrome**
- **Allergic reactions**


Continued from:
Tactical Evacuation Guideline
or
Snakebite Envenomation Managememnnet
Patient presents with signs and symptoms of sudden collapse syndrome post snakebite
Stabilize with Epinephrine:
IM: 0.3-0.5mg (0.3-0.5 mL 1:1000) or EpiPen®
IV Bolus: 100 mcg over 5-10 min; mix 0.1mg (0.1 mL of 1:1000 in 10mL NS, and infuse over 5-10 min)
Initiate infusion if hypotension not responsive to IM/IV:
IV Infusion: Start at 1 mcg/min; mix 1mg (1 mL of 1:1000 in 500 mL NS, and infuse at 0.5 mL/min; titrate as needed
Airway edema responsive to Epinephrine
NO
Airway Guideline
YES
Regional Antivenom Available?
YES
NO
Administer high dose (6 vials) of appropriate regional antivenom by rapid IV/IO push:
(Refer to JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG) Global Snake Envenomation Management (CPG ID: 81) for 1st and 2nd line ANTIVENOM based on Region and Syndrome. Follow JTS CPG for ANTIVENOM administrations.)
Establish Advanced Airway per procedure in the following sequence:
(Move to next procedure per individual competencies, contraindications, and/or attempt failures)
ENDOTRACHEAL INTUBATION
BIAD
CRICOTHYROIDOTOMY
Maintain SBP >90<100 with IV/IO Fluid Resuscitation and Epinephrine and transport to location with appropriate regional antivenom
See Snakebite Envenomation Clinical Syndromes Guideline
When appropriate, return to:
Snakebite Envenomation Management: General Principles
and/or
Tactical Evacuation Guideline

Pearls:

- Anaphylactic reactions (or hypovolemic shock) should be treated aggressively while simultaneously treating for severe envenomation with appropriate regional antivenom.
- Priority of care for a patient in snakebite sudden collapse syndrome is the consideration of the shorter of two options: ***evacuating the patient to a location with antivenom*** or ***bringing the antivenom to the patient.***
- Most patients presenting with hypotension or angioedema are responsive to epinephrine, but may require IV epinephrine infusions to achieve this effect if they are unresponsive to IM epinephrine

Global Spider and Scorpion Envenomation

Background:

Spider and scorpion envenomations can occur in many environments in which the military operates. Many arthropods possess a significant venom but lack a sufficient apparatus (fangs or talon) to inject it into humans. Most bites and stings involve more danger from anaphylaxis, but several species of spiders and scorpions have significant neurotoxic, cytotoxic, or hemotoxic venoms. While most spider and scorpion envenomations result in mild symptoms, severe toxicity and death can occur. Anaphylaxis is the most concerning initial effect. Recognize and treat it immediately using standard acute allergic reaction therapies. Anaphylaxis from an arthropod envenomation is not an indication for antivenom.

SPIDERS:

While many spider species produce venom, the vast majority lack sufficiently large or strong enough fangs to penetrate human skin and cause clinically significant effects. However, spiders venomous to humans can be found throughout much of the world. The chart below provides information regarding clinically significant venomous spider species.

Clinically Significant Venomous Spider Species			
	Widow Spiders *(Latrodectus spp)* *a.k.a* *Black Widow* *Red Widow* *Brown Widow*	**Violin Spiders** (Laxosceles reclusa) a.k.a Brown Recluse Fiddleback Spider	**Funnel Web Spiders** (Atrax) a.k.a Australian Funnel-Web Spider
Africa	X	X	
Asia	X	X	
Australia	X	X	X
Europe	X		
North America	X	X	
South America	X	X	
Picture			
Antivenom Available	Yes	No	Yes

Global Spider and Scorpion Envenomation (Continued)

Scorpions:

Scorpions envenomate humans by stinging them with the telson on their tail. Around 20 species of medically important (meaning potentially lethal to humans) scorpions are known, and all but one of these (Hemiscorpius lepturus) are members of the Buthidae family. Buthidae family contains the large genera Ananteris, Centruroides, Compsobuthus, and Tityus. Centruroides are the only clinically significant venomous scorpion indigenous to the United States (i.e. Bark Scorpions). The majority of medically significant envenomations occur in the Middle East, tropics (e.g., Southwest Asia, India, Central and South America), and North Africa.

Scorpion venoms are complex and can include phospholipase, acetylcholinesterase, hyaluronidase, serotonin, and neurotoxins. Scorpion venom increases neuronal release by blocking inactivation of the sodium channel, resulting in an increase in the amplitude and duration of neuron action potential. The overall result is excess stimulation of the central nervous system, the neuromuscular system, the sympathetic nervous system, and the parasympathetic nervous system.

The components of scorpion venom are species specific and generally fall into the categories of neurotoxic and cardiotoxic; however, this terminology is misleading since the cardiotoxic effects are secondary to an excess release of catecholamines stimulated by the nervous system. The venom of the unique species, Hemicorpius lepturus, found in Iraq and Iran is predominately cytotoxic, similar to the brown recluse spider.

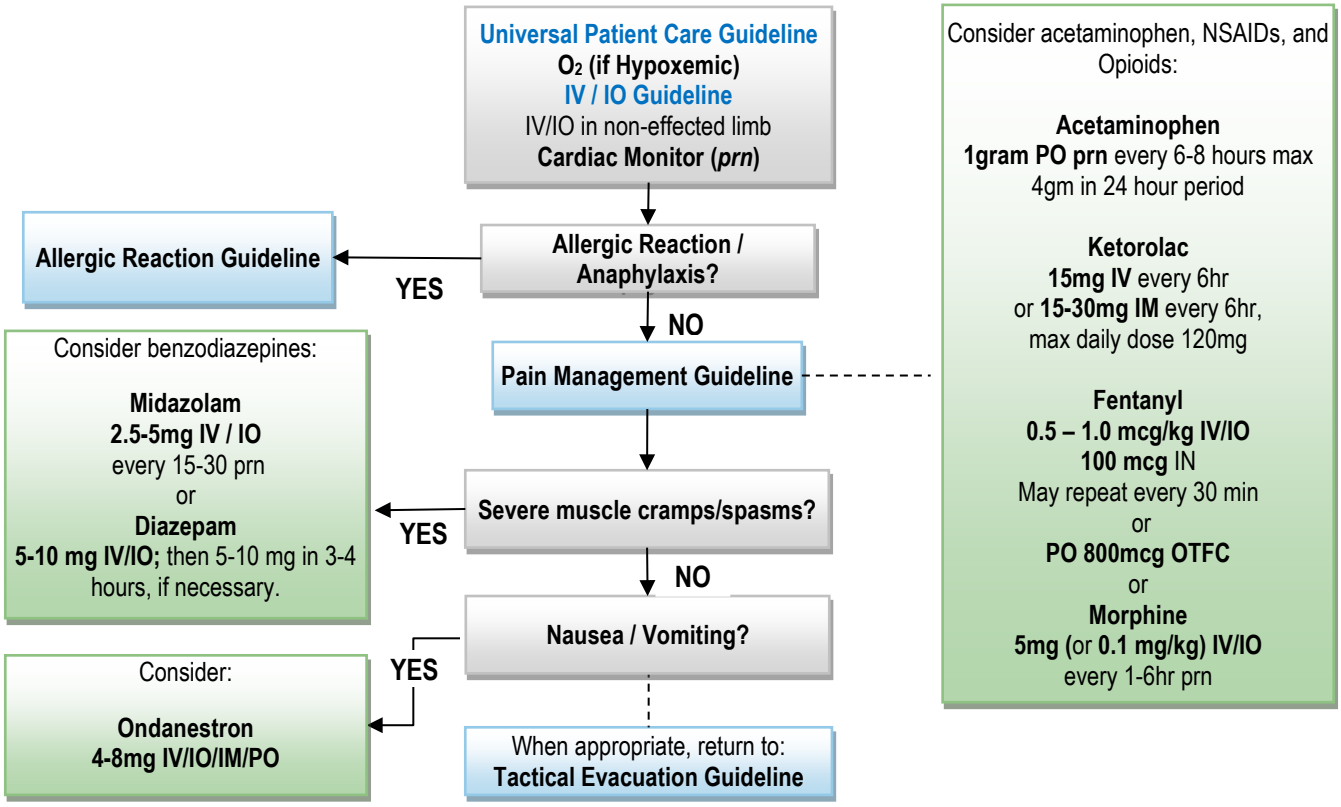
Antivenom is available for some species; data regarding the benefits and risks of many of these antivenoms are significantly limited. In patients with moderate to severe symptoms refractory to analgesics and benzodiazepines, antivenom, if available, may be indicated. Due to the high risk of immediate or delayed allergic reactions to these antivenoms administration should be done at a controlled clinical location and pre-hospital treatment should be focused on supportive care. Intravenous histamine antagonists (i.e. diphenhydramine), steroids, and epinephrine should be immediately available at the patient's bedside prior to antivenom administration. The Joint Trauma System Clinical Practice Guideline: Global Spider and Scorpion Envenomation Management (CPG ID: 84) contains a list of antivenoms available by country. (https://jts.amedd.army.mil/assets/docs/cpgs/Global_Spider_and_Scorpion_Envenomation_Management_09_Feb_2021_ID84.pdf)

Prehospital/En Route Care Treatment Goals for Spider and Scorpion Bites and Stings:

Some moderate to severe cases of envonomations will require medical evacuation to a treatment facility with the capability to administer antivenom. En Route Care consists primarily of supportive care and pain management. En route care providers should be prepared to counter cholernergic, adrenergic, sympathetic and parasympathetic effects. Aggressive use of benzodiazepines as indicated for agitation, neuromuscular stimulation, tachycardia, and hypertension. Secure the airway and initiate mechanical ventilation if indicated. Anaphylaxis is the most concerning initial effect. See specific treatment guidelines for Widow Spiders, Funnel-Web Spiders and Scorpions for additional guidance.

Widow Spider Envenomation

Patients may or may not feel a pinprick upon the initial bite. A pair of small red spots at the envenomation site may be visible; however, the bite site is often not located. Some patients do not develop systemic toxicity. In those patients who do, symptoms typically begin 15 to 60 minutes following the envenomation. The primary symptom is painful muscle cramping, starting at the bite site and progressing towards the center of the body. Patients may develop a painful, rigid abdomen secondary to abdominal muscle spasm which may be mistaken for peritonitis. The pain increases over time and may occur in waves. In some cases, the patient develops a temporary diaphoretic, grimaced, and contorted appearance of the face referred to as "facies latrodectismica." Other symptoms include vomiting, diaphoresis, tachycardia, hypertension (often profound), and restlessness. Symptoms of Latrodectus envenomation last hours to days. Fatalities from Latrodectus envenomation are exceedingly rare and, when they do occur, are secondary to cardiac arrest (presumably from severe hypertension in patients with predisposing medical conditions) and wound infection.

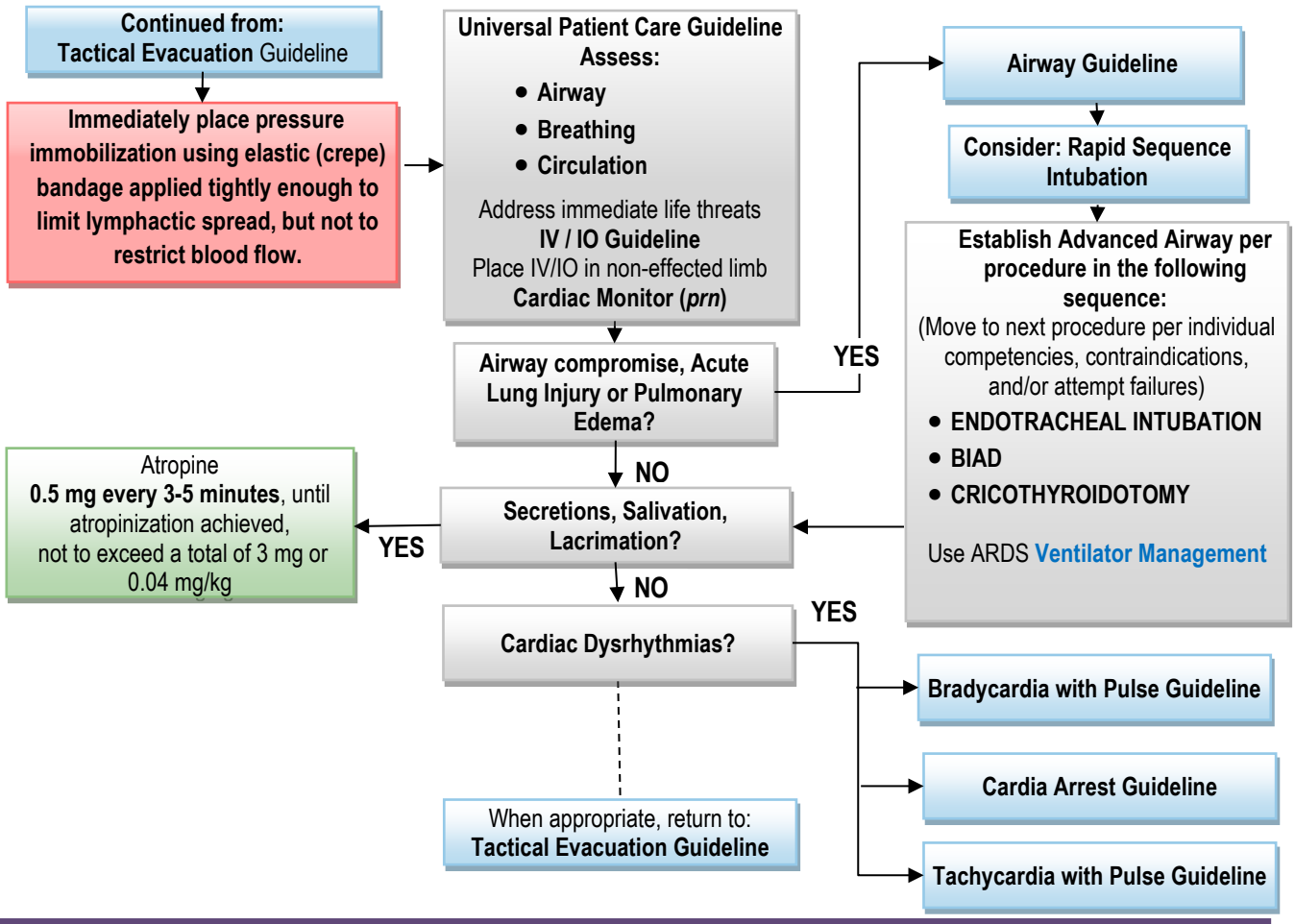


Pearls:

- Review country environmental concerns before deployment or visitation.
- **Anaphylactic reactions should be treated as soon as recognized**.
- Given the low risk of infection, antibiotics are not routinely recommended.
- Depending upon the severity of pain, acetaminophen, nonsteroidal anti-inflammatory agents, and opioids can be used for pain control.
- **Ketamine is not recommended** as patients may develop tachycardia and have profound hypertension due to widow spider toxin.
- Benzodiazepines may improve muscle spasms.
- Pain control and benzodiazepines are often sufficient to manage tachycardia and hypertension.
- Patients with severe pain refractory to pain medications, antivenom (if available) may be indicated, evacuate to MTF where antivenom is available if able.
- Elevate effected limb to reduce swelling.
- ***DO NOT apply constricting bandages or tourniquets*** as these may worsen local tissue injury and increase the risk of permanent disability.
- ***DO NOT*** cut, suck, electrocute, burn, or use chemicals on the envenomation site.

Funnel Web Spider Envenomation

The lethal component of funnel web spider venom is robustotoxin. It induces an autonomic storm by causing excessive release of acetylcholine, norepinephrine, and epinephrine. Funnel web spider envenomation causes a biphasic envenomation syndrome. The first phase includes pain at the bite site, perioral tingling, piloerection, and regional fasciculations which may progress to muscle spasm. This muscle spasm may involve the face, tongue, and larynx leading to airway compromise. The increased stimulation of cholinergic and adrenergic systems causes nausea, vomiting, lacrimation, salivation, tachycardia, hypertension, cardiac dysrhythmias, and acute lung injury. Acute lung injury is the predominate cause of death during the first phase. In the second phase the symptoms of the first phase resolve and lead to the gradual onset of refractory hypotension, apnea, and cardiac arrest.


Continued from: Tactical Evacuation Guideline
Immediately place pressure immobilization using elastic (crepe) bandage applied tightly enough to limit lymphactic spread, but not to restrict blood flow.
Universal Patient Care Guideline
Assess:
Airway
Breathing
Circulation
Address immediate life threats
IV / IO Guideline
Place IV/IO in non-effected limb
Cardiac Monitor (prn)
Airway compromise, Acute Lung Injury or Pulmonary Edema?
YES
Airway Guideline
Consider: Rapid Sequence Intubation
Establish Advanced Airway per procedure in the following sequence:
(Move to next procedure per individual competencies, contraindications, and/or attempt failures)
ENDOTRACHEAL INTUBATION
BIAD
CRICOTHYROIDOTOMY
Use ARDS Ventilator Management
NO
Secretions, Salivation, Lacrimation?
YES
Atropine
0.5 mg every 3-5 minutes, until atropinization achieved,
not to exceed a total of 3 mg or 0.04 mg/kg
NO
Cardiac Dysrhythmias?
YES
Bradycardia with Pulse Guideline
Cardia Arrest Guideline
Tachycardia with Pulse Guideline
When appropriate, return to:
Tactical Evacuation Guideline

Pearls:

- Immediately transport to an MTF with antivenom. Effective funnel web spider antivenom is available in Australia.
- **Anaphylactic reactions should be treated as soon as recognized**.
- Local tissue enzymes may inactivate the venom, therefore the use of pressure immobilization bandage may be helpful in delaying the onset of symptoms, but also may allow for a degree of inactivation of the venom.
- **Ketamine is not recommended** as patients may develop tachycardia and have profound hypertension.
- Benzodiazepines may improve muscle spasms.
- Elevate effected limb to reduce swelling.
- ***DO NOT*** cut, suck, electrocute, burn, or use chemicals on the envenomation site.

Scorpion Envenomation

Pearls:

- **Anaphylactic reactions should be treated as soon as recognized**.
- For clinically significant envenomation, management is supportive and focused on the patient's symptoms and graded 1-4.
- Patients graded 3 & 4 will require antivenom, evacuate to a MTF able to administer antivenom.
- Administer Benzodiazepines aggressively to ensure symptom control.
- For significant neuromuscular spasm, oral secretions, sedation, or other threats to the patent airway, perform endotracheal intubation to prevent aspiration and ensure adequate ventilation.
- Pulmonary edema should be managed with noninvasive or invasive ventilation in combination with optimization of cardiac output
- Direct acting vasopressors(epinephrine and norepinephrine) are recommended to treat bradycardia and hypotension
- Elevate effected limb to reduce swelling.
- ***DO NOT apply constricting bandages or tourniquets*** as these may worsen local tissue injury and increase the risk of permanent disability.
- ***DO NOT*** cut. suck. electrocute. burn. or use chemicals on the envenomation site.

Clinical Grade and Treatment of Scorpion Stings		
Grade	Effects	Treatment
1	Local Effects Only	Analgesia
2	Mild/Moderate autonomic excitation (i.e. tachycardia, hypertension)	Benzodiazepines
	Agitation and anxiety	Benzodiazepines
	Pain and paresthesias remote from the sting site	Analgesia
3	Pulmonary edema	Antivenom, noninvasive or mechanical ventilation
	Hypotension and cardiogenic shock	Antivenom, vasopressors (i.e., norepinephrine, epinephrine)
	Neuromuscular excitation, somatic neuromuscular dysfunction or cranial nerve dysfunction (associated with Centruroides species)	Antivenom, benzodiazepines
4	Multiorgan failure, coma, seizures, end-organ damage secondary to hypotension, somatic neuromuscular dysfunction and cranial nerve dysfunction (associated with Centruroides species)	Antivenom, vasopressors, sedation (benzodiazepine, propofol, phenobarbital), mechanical ventilation

Allergic Reaction / Anaphylaxis

Allergic Reaction Guideline

Airway Compromise

Airway Guideline

Rapid Sequence Intubation

Establish Advanced Airway per procedure in the following sequence:
(Move to next procedure per individual competencies, contraindications, and/or attempt failures)

- **ENDOTRACHEAL INTUBATION**
- **BIAD**
- **CRICOTHYROIDOTOMY**

Pulmonary Edema:
Use ARDS for
Ventilator Management

Analgesia
Consider acetaminophen, NSAIDs, and Opioids:

Acetaminophen
1gram PO prn every 6-8 hours max 4gm in 24 hour period

Ketorolac
15mg IV every 6hr
or **15-30mg IM** every 6hr,
max daily dose 120mg

Fentanyl
0.5 – 1.0 mcg/kg IV/IO
100 mcg IN
May repeat every 30 min
or
PO 800mcg OTFC

Increased Secretions / Salivation/ Lacrimation

Atropine
0.5 mg every 3-5 minutes, until atropinization achieved, not to exceed a total of 3 mg or 0.04 mg/kg

Benzodiazepines

Midazolam 2.5-5mg IV / IO every 15-30 prn
or
Diazepam
5-10 mg IV/IO; then 5-10 mg in 3-4 hours, if necessary

Hypotension / Cardiogenic Shock: Vasopressors

HYPOTENSION / SHOCK GUIDELINE

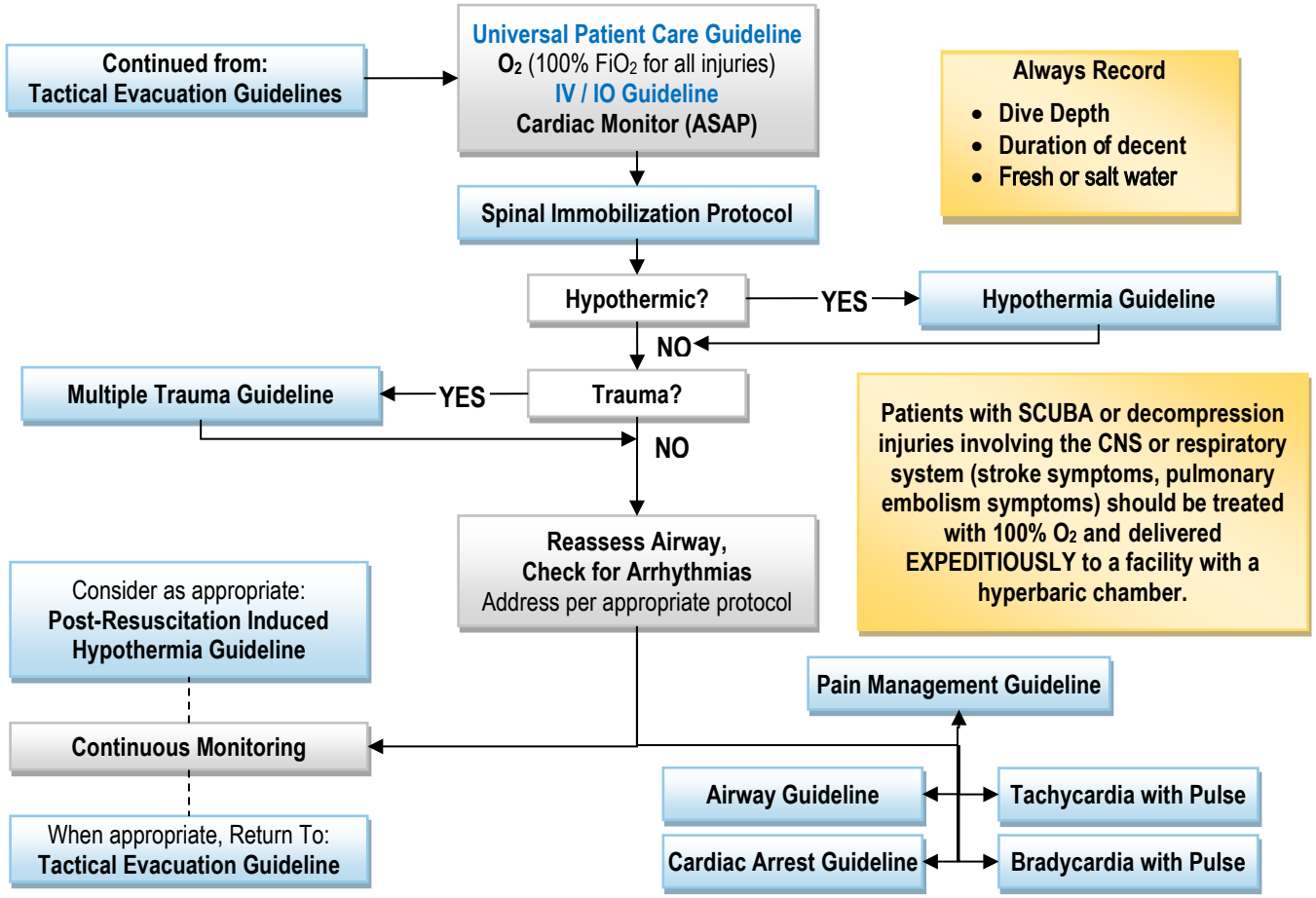
Norepinephrine
2-20mcg/min IV/IO, titrate to effect
(See **Norepinephrine Infusion Chart**)
or
Epinephrine 1mg/10ml
5-20 mcg IV/IO Push; may repeat ONCE in 2-5 minutes.
If patient remains hypotensive, proceed to continuous infusion.

2-10 mcg/minute; titrate to desired effect
(See **Epinephrine 1mg/10ml Infusion Chart**)

SUBMERSION INJURY

Signs and Symptoms:
- **Unresponsive**
- **Mental Status Changes**
- **Hypoxia**
- **Cyanosis**
- **Hypothermia**
- **Vomiting**
- **Coughing**

Differential Diagnosis:
- **Trauma (esp. C-spine)**
- **Dysbarism**
- **Pressure Injury as in Self-contained under water breathing apparatus (SCUBA)**



Pearls:
- If Decompression Illness or arterial gas embolism is suspected and neurological deficits (including altered mental status) are present, consider high-flow oxygen, lidocaine 1.5 mg/kg IV / IO, and aspirin 325mg. While these interventions remain unproven, the risk / benefit ratio makes them acceptable options, particularly if time to hyperbaric chamber is anticipated to be prolonged.
- Rapid hypothermia from cold water immersion in children has resulted in survival despite prolonged downtime – resuscitate per appropriate protocols and rapidly transport. This has not been seen in adults.
- All near-drowning victims should be transported for evaluation due to potential for worsening respiratory status over next several hours.
- Drowning is the leading cause of death among would-be rescuers.
- Head-first diving injuries often associated with unstable Jefferson fracture (burst fracture of C1) due to axial load. Patients found with suspicion of this type of injury should have early and careful C-spine immobilization.
- Altitude should be restricted in patients suffering from decompression illnesses to prevent worsening. Should remain <1000 ft. AGL / 10,000 ft. MSL whenever possible.
    - Aggressive pre-planning for access to hyperbaric treatment facilities is encouraged if mission requirements warrant it.

CBRN CASUALTY MANAGEMENT

BASIC PRINCIPLES:

Initial care of the CBRN casualty should be approached in the same manner as other casualties. Life threats require prompt recognition and intervention, and non-life-threatening sequelae can be addressed when clinically appropriate. Early recognition and categorization of CBRN-exposed patients is the foundation for further management, and is key not only for initiating patient treatment but also for preventing contamination of medical personnel, equipment, and facilities. Thorough and appropriate decontamination is a core skill that requires planning and practice. Attention to details such as preventing hypothermia in patients undergoing decontamination and clinical reassessment at each stage of the process will reduce unnecessary morbidity. Basic life saving measures such as airway management and resuscitation are fundamental concepts that must be mastered at the appropriate level for each practitioner in the CBRN care chain.

CBRN CRITICAL TASK LIST:

1. Recognize CBRN exposure that requires action to protect self and others.
2. Don personal protective equipment (PPE) to prevent exposure in self and assist others with PPE.
3. Egress from the threat:
    a. Move upwind, uphill, upstream from threat.
    b. Utilize time/distance/shielding for protection.
4. Recognize signs/symptoms of CBRN exposure that prompt immediate self-treatment or treatment of others utilizing CRESS assessment. (RAPID IDENTIFICATION OF CHEMICAL WARFARE AGENTS).
5. Apply TCCC integrated with CBRN response [TCCC + CBRN = (MARCHE)^2]. (MARCHE^2)
6. Apply airway management skills in a CBRN setting (positioning, suction, ventilation to include manual.
7. Perform Rapid Spot Decontamination.
8. Identify and establish Hot/Warm/Cold Zones.
9. Establish a dirty casualty collection point (CCP).
10. Understand decontamination principles and casualty procedures for partial or complete removal of PPE, clothing, and equipment (casualty cut out).
11. Understand cross contamination and take appropriate measures to prevent it.
12. Understand available technology that can aid in agent identification.

CBRN MEDICAL REGULATING CONSIDERATIONS:

1. Military Treatment Facility (MTF).
    a. DECON/Treatment Coordination. Ensure MTF is prepared to receive dirty casualties and determine the most appropriate location for DECON.
    b. Treatment Capabilities (Toxicology, Critical Care, Trauma Surgery). Determine whether the MTF has the services necessary to care for and sustain the CBRN casualty on site and/or establish telemedicine support.
    c. Capacity. The CBRN casualty is far more resource intensive than a typical trauma or critically ill casualty. Assess the MTF's capacity and capability to treat CBRN casualties and identify potential alternate locations.
2. Integrate the medical regulating system into CBRN casualty evacuation.

EVACUATION PLATFORM CONSIDERATIONS:

1. Evacuation of patients must continue even in a contaminated environment.
2. Clean and Dirty. It is necessary to plan for both clean and dirty platforms for evacuation.
    a. Optimize the use of resources, medical or nonmedical, which are already contaminated before employing uncontaminated resources.
    b. Once a vehicle or aircraft has entered a contaminated area, it is highly unlikely that it will be able to be spared long enough to undergo a complete decontamination. Factors include - contaminant, the tempo of the battle, and the resources available.
    c. Contaminated vehicles (air and ground) will have restricted use and are confined to a contaminated environment until decontamination can occur.
3. Refuel.
    a. Consider the time it takes for refueling in a MASCAL situation, as well as the distance from the objective to the DECON site and MTF.
    b. Factor in any platform decontamination that may be necessary prior to arrival at the refueling site.
    c. WARM ZONE Forward Arming and Refuel Points may be necessary.
4. Preparation time (hasty vs. deliberate). Factor the time it takes to prepare the platform for a hasty or deliberate CBRN mission.
5. Radiological Exposure Limitations:
    a. Operational exposure guidance: MEDEVAC operations will establish operational exposure guidelines by the appropriate Surgeon and Command limiting radiation exposure to crews by absorbed dosage.
    b. Radiation exposure records are maintained by the unit CBRN noncommissioned officer and are made available to the commander, staff, and surgeon.
6. Flying Hour Limitations:
    a. Environmental Relative Factors (ERF) under Mission Oriented Protective Posture (MOPP) 3 and 4 limits flying hours to 3 hours day, night or combined modes of flight.
    b. ERF extensions are limited to a case by case basis.

CBRN LANDING ZONES / AMBULANCE (CASUALTY) EXHCHANGE POINTS:

1. Route coordination. Consider alternate routes, primary routes may be jammed or unavailable.
2. Consider appropriate distance to accommodate for aircraft rotor wash and direction of landing for Dirty LZs and Clean LZs at the DECON/CCP locations.
3. Environmental Considerations:
    a. Wind
    b. Terrain / Slope
    c. Drainage (for DECON Sites)
    d. Water Sources

CBRN MILITARY WORKING DOG CASUALTY MANAGEMENT

Chemical protective doctrine for animals is incomplete, and there is no chemical protective equipment in the current inventory for MWDs. Equipment and doctrine for animals are under development but pending its availability, any degree of protection of the MWD in a CBRN agent environment will, at best, be extremely difficult. The MWD's Handler should be in possession of additional ATNAA and CANA kits to use on their MWD. Attempt to obtain and use those resources first when treating a MWD.

MILITARY WORKING DOG DECONTAMINATION PROCEDURES

While not generally a MEDEVAC mission, ensuring proper MWD Decon prior to transport is vital to ensuring the platform and crew are not contaminated by the agent involved.

- Rinse the MWD thoroughly with plain water beginning at the head along the back and to the tail; then rinse down the MWD's sides, chest, stomach, legs, and paws.
- Work the soap into the hair starting the head, along the back and to the tip of the tail, then work down the MWD's sides, chest, and abdomen, legs, and paws. Ensure the soap reaches the MWD's skin. If the MWD has erect ears, flush the ears with otic solution or water.

Note. Special attention should be paid to the MWD's stomach, face, ears, eyes, under tail, paws and in between legs to ensure all contamination is removed.

- Flushed the eyes with copious amounts of water, ophthalmic solution, or saline.
- Rinse with plain water using the same pattern as the initial rinse (head to back to tail, then down sides, chest, stomach, legs, and paws).
- Allow the MWD to shake off excess water. A tarp or other impervious materiel may be placed around the MWD while it shakes off excess water to prevent contaminating of other people, MWDs, or equipment.

TREATMENT OF MILITARY WORKING DOG CASUALTIES OF NERVE AGENTS

- For mildly exposed MWDs, administer a total of two ATNAA injections (atropine and 2-PAM Cl in a single autoinjector) (carried by the MWD handler) into the back of the thigh of the dog. The initial dosage of atropine is 4 mg and the dosage for 2-PAM Cl is 1200 mg

- For severely exposed MWDs, administer three ATNAA and one CANA. This is similar to the buddy aid a Service member provides another Service member suffering from severe nerve agent exposure. In general, MWDs should not need additional 2-PAM Cl injections.

- Single atropine injections may be given every 10 to 20 minutes until the nerve agent effects have subsided or signs of atropinization appear. The MWD must be monitored for heat stress. Atropine dries the mucous membranes thus preventing the MWD from expelling body heat.

- The initial dosage of 2-PAM Cl in the dog is 20 mg/kilogram. Three ATNAA injectors should provide sufficient amount of 2-PAM Cl. If a MWD is still showing signs of seizure after initial

treatment, the handler may give up to 3 additional CANA autoinjections at 5 to 10 minute intervals until the seizures are gone.

- Maintain a clear airway by removing respiratory secretions and saliva obstructing the airway. Loosen or remove the muzzle. In severe nerve agent exposure, the animal's respiration is markedly depressed and extreme muscular weakness or paralysis is present. In such cases, assisted ventilation is required to effectively resuscitate the animal.

Adequate atropine and 2-PAM Cl should bring about an improvement or restoration of spontaneous respiration and also improve blood circulation. However, the effectiveness of 2-PAM Cl is lost after a short period of time. The 2-PAM Cl varies in its effectiveness against nerve agents. It is least effective against GD nerve agent. In some cases, severe nerve agent symptoms may persist or recur and require veterinary personnel to administer additional 2-PAM Cl autoinjectors every 8 to 12 hours for up to 3 days.

MARCHE^2

After initial assessment of casualty in CBRN-threat environment for the presence or absence of CBRN symptoms using the CRESS algorithm, the integrated assessment and management of TCCC and CBRN injuries can proceed. MARCHE^2 integrates the TCCC MARCH algorithm with the priorities of CBRN treatment. MARCHE^2 is further broken down into phases similar to TCCC. The "Hot Zone" should be considered as care under fire, addressing only immediate life threats, "Warm Zone" is tactical field care and "Cold Zone" as tactical evacuation care.

MARCHE^2 Algorithm

TCCC MARCH

MASSIVE HEMORHORAGE

- HASTY tourniquets in the HOT ZONE
- Transition to DELIBERATE tourniquets during DECON in WARM ZONE

AIRWAY

- Assess – excessive secretions indicate **NERVE AGENT**
- Defer most interventions - consider risks in active HOT ZONE of remove mask to access airway

Respirations

- Increased respirations consider **ATNAA/CANA NERVE AGENT GUIDELINE**
- Depressed respirations consider **NAXOLONE INCAPACITATING AGENT GUIDELINE**
- Other than antidotes – respiratory interventions is best deferred to WARM ZONE

Circulation

- Circulation intervention should be deferred to WARM ZONE
- Assess for shock
- **IV/IO GUIDELINE**
- **HYPOTENSION/SHOCK GUIDELINE**

CRESS Assessment

Consciousness:
Conscious, Unconscious, depressed consciousness, AMS, seizures, agitation, normal

Respirations:
Normal, increased, decreased, distress, delayed onset, apneic, tachypnea, wheezing, immediate irritation

Eyes:
Normal, constricted (Miosis), dilated (Mydriasis), irritated, painful,

Secretions:
None, Increased, Decreased Copious Secretions (salivation, lacrimation, rhinorrrhea, bronchorrhea),

Skin:
Normal, Dry and Hot, Flushed, Erythema, Diaphoresis, Cyanotic, Blisters, Pain

CRESS must be reassessed regularly, during zone transitions and at each transfer, to monitor for delayed onset of life threatening symptoms, and analyze antidote or countermeasure effectiveness

CBRN MARCHE^2

Mask

- MASK or CHECK MASK SEAL as immediate HOT ZONE treatment

Antidote

- Utilize CRESS to differentiate chemical agent exposure **RAPID IDENTIFICATION OF CHEMICAL WARFARE AGENT**
- **ATNAA** (x3)/**CANA** (x1) for **NERVE AGENT**
- **NAXOLONE** (2mg IM) for OPIOID **INCAPATICITATING AGENT**
- Can consider **Cyanokit®** in HOT ZONE for **BLOOD AGENT** if symptoms are severe, first action should be removal from area of exposure and rapid spot decontamination

Rapid Spot Decontamination

- Indicated for gross contamination on skin and/or wounds or if protective gear is breached
- Rapid exposure and decontamination of contaminated wounds is necessary lifesaving procedure in the HOT ZONE
- Apply RSDL, M100, M295, Sorbent, tech wipe, etc.

Countermeasures

- Appropriate therapy based on type of agent exposure, post initial antidote administration
- Deferred to WARM ZONE

Hypothermia Prevention & Head Injury

- Protect from lethal triad: **HYPOTHERMIA**, acidosis and coagulopathy through HOT/WARM/COLD ZONES
- Active warming or HPMK post decontamination and packaging for further evacuation
- Determine if altered mental status is due to chemical agent or trauma, if trauma **HEAD INJURY/TBI GUIDLINE**

Extricate and Evacuate

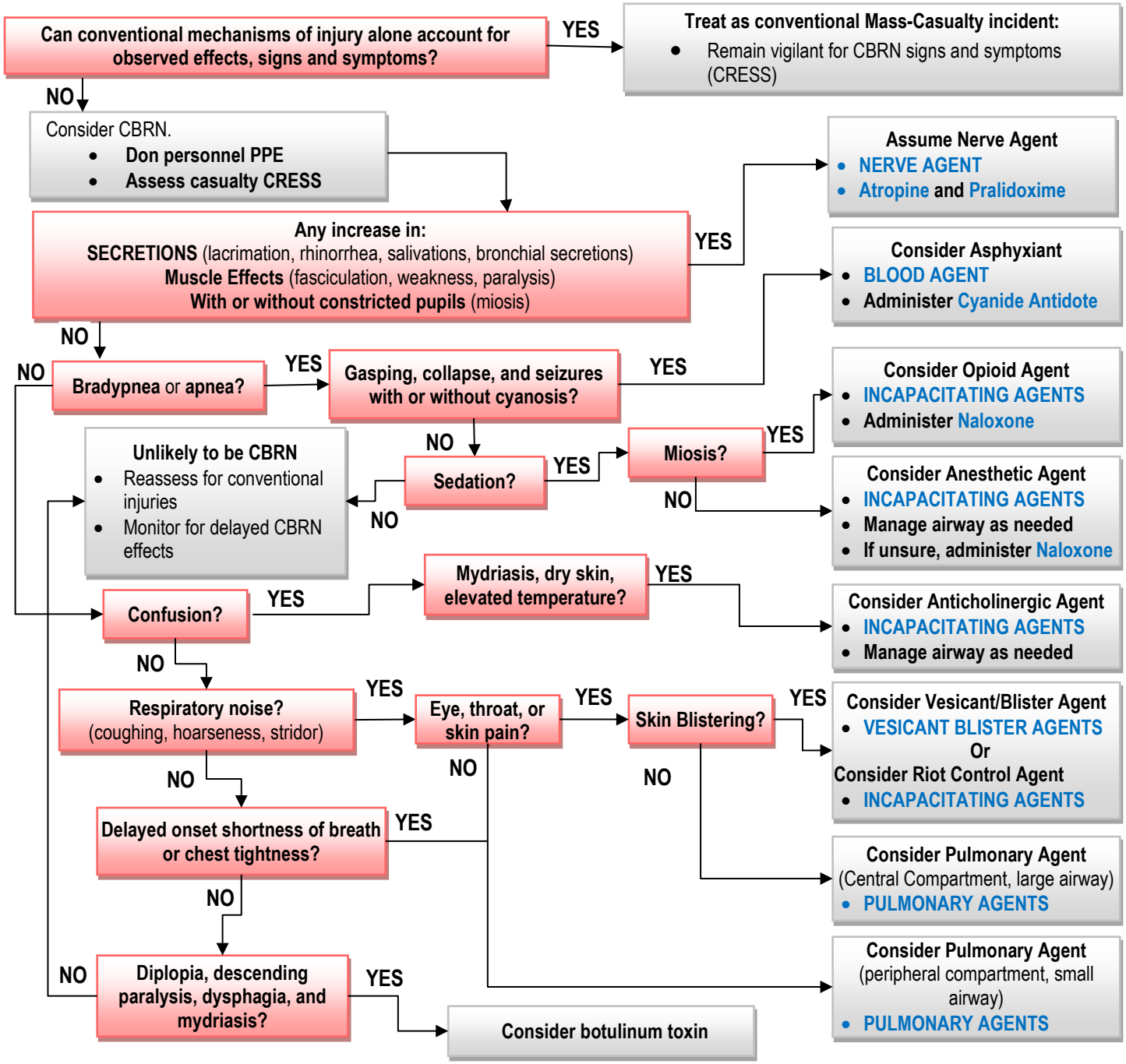
- EXTRICATE: egress patient from threat, agent contact, HOT ZONE
- Evacuate: to WARM ZONE – Dirty CCP for decontamination
- COUNTERMEASURES and appropriate supportive care starts in WARM ZONE and continues during Evacuation/COLD ZONE

Pearls:

- Treatment goals of CBRN is give antidote, extricate from exposure area, conduct spot decontamination, provide airway support.

RAPID IDENTIFICATION OF CHEMICAL-WAFARE AGENTS

Assess:	Observations:
C- Consciousness	• unconscious, seizures, depressed consciousness, agitation
R- Respirations	• present, absent, labored, increased, decreased, normal, abnormal
E- Eyes	• constricted, dilated, normal
S- Secretions	• dry, normal, increased
S- Skin	• diaphoretic, dry, hot, cyanosis



Pearls:

- Treatment goals of CBRN is give anti-dote, provide airway support, conduct spot decontamination.

NERVE AGENT

Nerve Agent
- Liquid or Vapor
- Non-Persistent (GA, GB, GF)
- Persistent (VX)
- Organophosphate Treatment

PPE and Detection
- Mask
- AP-PPE
- JLIST or UIPE

M8 Detection Paper
- G – Yellow
- V – Green

CRESS Symptomatic Presentation
C: altered, unconscious, seizures
R: tachypnea, wheezing, respiratory distress
E: miosis (may or may not be present with organophosphate)
S: copious secretions (salivation, lacrimation bronchorrhea)
S: diaphoresis

HOT ZONE
POI

Immediate Action + M², A², R², E.
- address **MASSIVE HEMORRHAGE / Mask check**
- assess **AIRWAY** / administer **ANTIDOTE**
- asses **RESPIRATIONS** / conduct **RAPID SPOT DECON**
- **Extract** (move upwind, uphill, upstream – away from threat)

NERVE AGENT ANTIDOTE
Antidote Treatment, Nerve Agent, Auto-Injector (ATNAA)
- **ATNAA** contains **2.1mg Atropine** and **600mg Pralidoxime Cholride (2PAM)** in each Auto Injector
- Initial administration is **3x ATNAA** in rapid sequence for sever signs of nerve agent poisoning **(6.3mg Atropine, 1800mg 2PAM)**

Convulsant Antidote Nerve Agent (CANA)
- **CANA** contains **10mg Diazepam**
- Administer **1x CANA** following **3x ATNAA**

WARM ZONE
DIRTY CCP

M², A², R², Reassement (clear airway, O² as needed, filtered air)
- Decontaminate and Cutout

C², H², E
- **CIRCULATION** (asses vitals, resuscitate) administer **COUNTERMEASURES** as necessary if **ATNAA/CANA** administered and symptoms persist
- Prevent **HYPOTHERMIA** / assess mental status (altered due to agent or trauma?) **HEAD INJURY**
- **EVACUATE** to next role of care/zone

NERVE AGENT COUNTERMEASURES
ATROPINE IV/IO
- 20mg in 250mL NS IV/IO, titrate 1mg every 3 mins to dry secretions
- Once clinical improvement achieved, adjust to rate of 2-4mg/hr

PRALIDOXIME IV/IO
- 1-2gm in 250mL NS IV/IO over 15-30min.

BENZODIAZEPINES IV/IO
- **MIDAZOLAM** (preferred)1-2mg IV/IO, titrate to effect
- **DIAZEPAM** 10-20mg IV/IO, titrate to effect

SCOPOLAMINE IV/IM (adjunct if available)
- 0.8mg IV/IM

COLD ZONE

MARCHE² Reassessment
- Continue to address any immediate life threats
- provide **AIRWAY** and **RESPIRATORY** support as necessary
- continue **CIRCULATION** support / **COUNTERMEASURES** as symptoms dictate
- prevent **HYPOTHERMIA** with HPMK, warm fluids / **HEAD INJURY** treat elevated ICP, conduct neuro exam, MACE

Reassess regularly, follow protocols for respiratory or cardiac compromise.

BLOOD AGENT - CYANIDE

Blood Agent – Cyanide
- Hydrogen Cyanide, Cyanogen Chloride
- volatile water-soluble liquid
- vapor
- Odor: Bitter Almonds

PPE and Detection
- Mask
- AP-PPE
- JLIST or UIPE

M8 Detection Paper
- Does not detect

CRESS Symptomatic Presentation
C: altered or unconscious
R: normal to apneic
E: normal unless vapor irritant
S: none
S: may appear flushed (50% occurrence)

HOT ZONE
POI

Immediate Action + M², A², R², E.
- address **MASSIVE HEMORRHAGE / Mask check**
- assess **AIRWAY** / administer **ANTIDOTE**
- asses **RESPIRATIONS** / conduct **RAPID SPOT DECON**
- **Extract** (move upwind, uphill, upstream – away from threat)

CYANIDE ANTIDOTE
HYDROXOCOBALAMIN (Cyanokit®) IV/IO
- **5gm IV/IO over 5min with 200ml NS or LR or D5W**
- Do not shake vial (gently mix)
- Do not use if solution is not dark red
- Reapeat second 5gm dose based on severity and clinical response
- Maximum cumalitive dose 10gm

Antidote Considerations:
Decision to give in hot or warm zone is based on clinical presentation. Unlikely to have diagnostic adjuncts (lactate, arterial/venous samples) prior to cold zone. High concentrations of cyanide can result in death within seconds to minutes. Early symptoms may include dizziness, headache, weakness, diaphoresis, and dyspnea / hyperpnea. CNS and cardiotoxicity occur due to intracellular hypoxia.
- **Consider amyl nitrite (0.3mL ampule)**
- If Cyanokit® (hydroxocobalamin) antidote is not available, aggressive supportive care may be sufficient treatment.

WARM ZONE
DIRTY CCP

M², A², R², Reassement (clear airway, O^2 as needed, filtered air)
Decontaminate and Cutout
- Remove and bag equipment, PPE, and clothing
- Evacuation from exposure + clothing removal is adequate decon
- Can further decontaminate skin with irritation solution, but priority is antidote

C², H², E
- **CIRCULATION** (asses vitals, resuscitate) administer **COUNTERMEASURES** (initial or second **Cyanokit®**)
- Prevent **HYPOTHERMIA** / assess mental status (altered due to agent or trauma?) **HEAD INJURY**
- **EVACUATE** to next role of care/zone

COLD ZONE

MARCHE² Reassessment
- Continue to address any immediate life threats
- provide **AIRWAY** and **RESPIRATORY** support as necessary, provide **supplemental O_2** even with normal SPO_2
- continue **CIRCULATION** (monitor)t / **COUNTERMEASURES** 2nd dose as appropriate)
- prevent **HYPOTHERMIA** with HPMK, warm fluids / **HEAD INJURY** treat elevated ICP, conduct neuro exam, MACE

Anticipate hemodynamic compromise, seizures, cardiac arrhythmiasReassess regularly, follow protocols for respiratory or cardiac compromise.

PULMONARY AGENTS

Pulmonary Agents: Phosgene, Chlorine

- Phosgene, Chlorine
- Gas ($COCL_2$) above 47°F/8.3°C
- Gas (Cl) above 29°F/-1.6°C
- Odor Phosgene: freshly mowed hay
- Phosgene toxic below odor threshold

PPE and Detection

- Mask (C2-A1 Filter)
- AP-PPE
- JLIST or UIPE

M8 Detection Paper

- Not effective

CRESS Symptomatic Presentation

C: conscious (unconscious if asphyxia)
R: normal to respiratory distress, delayed onset up to 24 hours (phosgene)
E: irritated, injected (chlorine)
S: Mucous membrane irritation (rhinorrhea, salivation)
S: Chlorine: immediate irritation (tearing and rhinorrhea) Phosgene: delayed fluid buildup

HOT ZONE
POI

Immediate Action + M², A², R², E.

- address **MASSIVE HEMORRHAGE / Mask check**
- assess **AIRWAY** / administer **ANTIDOTE**
- asses **RESPIRATIONS** / conduct **RAPID SPOT DECON**
- **Extract** (move upwind, uphill, upstream – away from threat)

WARM ZONE
DIRTY CCP

M², A², R², Reassement (

- Clear airway (copious secretions)
- Anticipate laryngospasms
- Place advanced airway (largest bore ET as able), be prepare to conduct cricothyroidotomy for failed airway
- Advanced Ventilatory support (SAVe or simple vent may not be sufficient, ARDS technique, need to manipulate peep, volume, FIO2)
- O_2 as needed, maintain air filter

Decontaminate and Cutout

- Remove and bag equipment, PPE, and clothing
- Soap and water sufficient for skin decon
- Remove and replace contaminated treatments (chest seals, tourniquets, etc.)

C², H², E

- **CIRCULATION** (asses vitals) **COUNTERMEASURES**
- Prevent **HYPOTHERMIA** / assess mental status (altered due to agent or trauma?) **HEAD INJURY**
- **EVACUATE** to next role of care/zone

COLD ZONE

MARCHE² Reassessment

- Continue to address any immediate life threats
- provide **AIRWAY** and **RESPIRATORY** support as necessary, provide **supplemental O_2** even with normal SPO_2
- continue **CIRCULATION** support (monitor vitals), resuscitate as necessary / **COUNTERMEASURES** 2nd dose as appropriate)
- prevent **HYPOTHERMIA** with HPMK, warm fluids / **HEAD INJURY** treat elevated ICP, conduct neuro exam, MACE

There is no antidote for Chlorine or Phosgene exposure. Treatment focus is remove from exposure, aggressive management of airway and respirations, supportive care.

PHOSGENE: Onset of symptoms can be delayed up to 24 hours, generally 2-6 hours after exposure. Exertion is associated with worse outcomes, so keep patients exposed to phosgene at rest. The major effects of phosgene are on peripheral airways, therefore dyspnea, chest tightness or pain, and cough are common symptoms. Development of hypoxia and pulmonary edema. Fluid shifts secondary to pulmonary edema may result in hypovolemia.

Chlorine: Onset of symptoms are immediate. Chlorine causes more immediate symptoms in the moist areas of the eyes, mouth, and upper airways. Eye pain, blepharospasm, and lacrimation are common. Other symptoms may include headache, salivation, dyspnea, cough, hemoptysis, chest burning, and vomiting. Irrigate eyes if irritated or burning.

Laryngospasm may occur with both Phosgene and Chlorine. Anticipate airway edema and manage airway early. If advanced airway required, place largest endotracheal tube possible to facilitate suctioning. Intravenous fluids may be necessary in the setting of volume depletion, but should not be given empirically. Fluid overload can contribute to pulmonary edema and should be avoided.

Consider following for wheezing /bronchospasms:

- **ALBUTEROL (2.5mg in 3ml NS)**
- **METHYPREDNISOLONE (125mg IV)**
- **See RESPIRATORY DISTRESS**

Mechanical Ventilations

- Use **ARDS VENTILATOR MANAGEMENT** techniques

VESICANT BLISTER AGENTS

Vesicant Agents: Anticholinergics, Opioids, Riot Control
- Lewisite (L), Mustard-Lewisite Mixture (HL)
- Immediate Acting Agent
- Oily liquid
- Persistent, Freezing 0.4°F/-17°C
- Odors: Geraniums

PPE and Detection
- Mask
- AP-PPE
- JLIST or UIPE

M8 Detection Paper
- Red to Pink

LCD Detection
- Red or Orange H

CRESS Symptomatic Presentation
C: Conscious (unconscious due to other effects)
R: Immediate irritation, distress
E: Immediate severe pain, blepharospasm edema
S: Normal to increased
S: Immediate pain, erythema, blisters form hours later
OTHER: Systemic effects – distributive shock

HOT ZONE
POI

Immediate Action + M², A², R², E.
- address MASSIVE HEMORRHAGE / **Mask check**
- assess AIRWAY / administer **ANTIDOTE (none in HOT ZONE)**
- asses **RESPIRATIONS** / conduct **RAPID SPOT DECON**
- **Extract** (move upwind, uphill, upstream – away from threat) Extraction to the Dirty CCP [For Small Spills (< 2 kg) move away 100m day/300m night] [Large Spills (< 25kg) = 500m day/1000m night]

WARM ZONE
DIRTY CCP

M², A², R², Reassessment
- Clear airway, O_2 as needed, maintain filtered air
- ALBUTEROL **(2.5mg in 3ml NS)**
- Invasive airway if unresponsive to albuterol

Decontaminate and Cutout
- Remove and bag equipment, PPE, and clothing
- Wipe away gross contamination, RSDL cut line, cut out
- RSDL residual contamination on skin (>2min contact time, then wipe away)
- Remove and replace contaminated treatments (chest seals, tourniquets, etc.)

C², H², E
- **CIRCULATION** (asses vitals, resuscitate) **COUNTERMEASURES** (rapid decon, irrigate eyes and wounds with water)
- Prevent **HYPOTHERMIA** / assess mental status (altered due to agent or trauma?) HEAD INJURY
- **EVACUATE** to next role of care/zone

COLD ZONE

(MARCHE)² Reassessment
M²: Convert tourniquets & bandage wounds
A²: In case of severe inhalation symptoms upgrade airway adjunct & RSI
R²: Vesicant Inhalation Tx SOP, Ventilator, O2 , PEEP, Suction, Bronchoscopy
C²: Trend Vitals, TXA, FDP, FWB, Fluid Challenge if Req'd / severe exposures will present with distributive shock requiring chelation therapy with Dimercaprol aka British Anti-Lewisite (BAL) in order to resolve
- **H2:** Hypothermia (HPMK, fluid warmer) / Head wounds (treat elevated ICP, Neuro exam, MACE) **HEAD INJURY** treat elevated ICP, conduct neuro exam, MACE

Lewisite binds to tissues and absorbs systemically within two minutes of contact. Symptoms begin to manifest immediately upon exposure and worsen over time. Control of massive hemorrhage and rapid spot decon are top priorities.

Casualties with palm-size exposure without rapid decon, >5% BSA burn, pulmonary edema, or shock symptoms with rapid onset require chelation. Early pain control may be required to ensure casualty cooperation. Administration of BAL within 5 minutes of exposure to skin and eyes can neutralize agent.

COUNTERMEASURE / TREATMENT
Dimercaprol (BAL) Administration
- Initial Dose: 3 mg/kg deep IM repeat every 4 hours for two days
- Then: Every 12 hours for 7-10 days
- Severe & Life Threating Exposure: consider 5 mg/kg
- Side Effects: Increased BP, Tachycardia, Nausea/vomiting, Headache, Anxiety, Injection Necrosis
- Contraindications: Nut Allergy.

Supportive Care
- PAIN MANAGEMENT
- Expect **SIRS** and **ARDS** in severe cases

Mechanical Ventilations
- Use **ARDS** VENTILATOR MANAGEMENT techniques

Skin
- Burns-apply Silvadene & bandage QID (burn fluid resuscitation not necessary
- Blister fluid may contain Arsenic, unroof >2cm, irrigate, calamine or steroidal cream

Eyes
- Petroleum based ophthalmic ointment,

INCAPACITATING AGENTS

Incapacitating Agents: Anticholinergics, Opioids, Riot Control
- Variable; aerosol, smoke/gas, or liquid
- Fentanyl derivatives extremely potent lethality

PPE and Detection
- Mask (C2-A1 Filter)
- AP-PPE
- JLIST or UIPE

M8 Detection Paper
- Not effective

CRESS Symptomatic Presentation
C: Varies with agents
R:
E:
S:
S:

HOT ZONE
POI

Immediate Action + M², A², R², E.
- address MASSIVE HEMORRHAGE / **Mask check**
- assess AIRWAY / administer **ANTIDOTE**
- asses **RESPIRATIONS** / conduct **RAPID SPOT DECON**
- **Extract** (move upwind, uphill, upstream – away from threat)

WARM ZONE
DIRTY CCP

M², A², R², Reassessment
- Clear airway (copious secretions)
- Anticipate laryngospasms
- Place advanced airway (largest bore ET as able), be prepare to conduct cricothyroidotomy for failed airway
- Advanced Ventilatory support (SAVe or simple vent may not be sufficient, ARDS technique, need to manipulate peep, volume, FIO2)
- O_2 as needed, maintain air filter

Decontaminate and Cutout
- Remove and bag equipment, PPE, and clothing
- Soap and water sufficient for skin decon
- Remove and replace contaminated treatments (chest seals, tourniquets, etc.)

C², H², E
- **CIRCULATION** (asses vitals) **COUNTERMEASURES**
- Prevent **HYPOTHERMIA** / assess mental status (altered due to agent or trauma?) HEAD INJURY
- **EVACUATE** to next role of care/zone

COLD ZONE

MARCHE² Reassessment
- Continue to address any immediate life threats
- provide **AIRWAY** and **RESPIRATORY** support as necessary, provide **supplemental O_2** even with normal SPO_2
- continue **CIRCULATION** support (monitor vitals), resuscitate as necessary / **COUNTERMEASURES** 2nd dose as appropriate)
- prevent **HYPOTHERMIA** with HPMK, warm fluids / **HEAD INJURY** treat elevated ICP, conduct neuro exam, MACE

OPOIDS
C – Sedation
R – Decreased respirations
E - miosis
S – normal
S- normal

OPIOID ANTIDOTE:
- NAXOLONE **(2-4mg)** additional escalating doses up to10mg dose as needed
- May require NAXOLONE drip at 2/3 of response dose/hr
- Support respirations as needed see RESPIRATORY DISTRESS

ANTICHOLINERGICS
C – Delirium, agitation
R – normal, tachypnea, tachycardia
E - red
S – mydriasis
S- red, hot dry

ANTICHOLINERGICS ANTIDOTE:
- Titrate Benzodiazepines **(2-4mg IV/IO/IM)** to control severe agitation
- Support respirations as needed see RESPIRATORY DISTRESS

Laryngospasm may occur with both Phosgene and Chlorine. Anticipate airway edema and manage airway early. If advanced airway required, place largest endotracheal tube possible to facilitate suctioning. Intravenous fluids may be necessary in the setting of volume depletion, but should not be given empirically. Fluid overload can contribute to pulmonary edema and should be avoided.

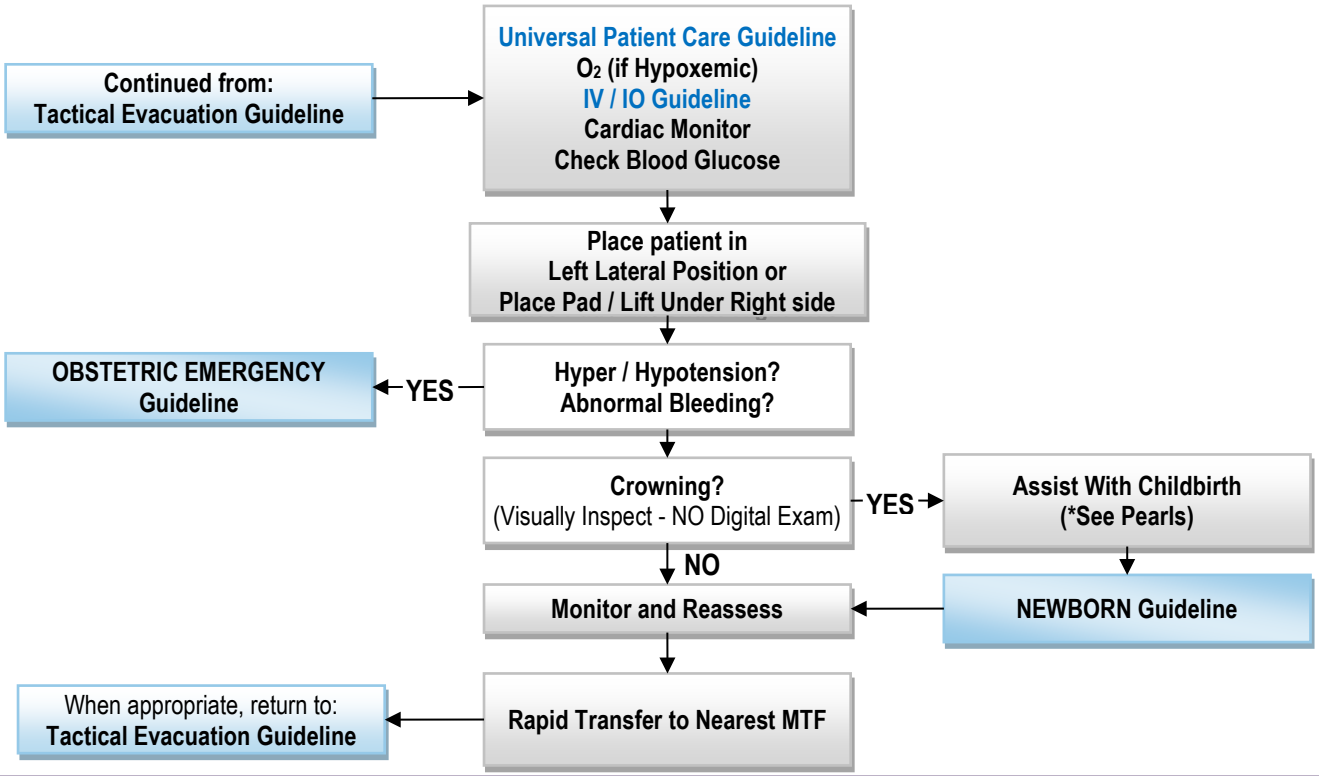
Consider following for wheezing /bronchospasms:
- ALBUTEROL **(2.5mg in 3ml NS)**
- METHYPREDNISOLONE **(125mg IV)**
- **See** RESPIRATORY DISTRESS

Mechanical Ventilations
- Use **ARDS** VENTILATOR MANAGEMENT techniques

CHILD BIRTH

Signs and Symptoms:
- **Spasmodic Pain**
- **Vaginal Fluid / Bleeding**
- **Crowning / Urge to Push**
- **Meconium**

Possible Complications:
- **Preterm Labor**
- **Spontaneous Vaginal Delivery**
- **Placenta Previa**
- **Prolapsed Cord**
- **Abnormal Presentation (e.g., breech)**



Pearls:

- Document all times – delivery, contraction frequency / length.
- Assist with birth:
  - Position mother as necessary.
  - Prepare 2 sets of hemostats and scissors / scalpel, umbilical cord clamp if available, bulb suction.
  - If umbilical cord palpable around neck– attempt to reduce manually prior to delivery of head (should feel rope-like structure around neck). As last resort, and if unable to keep pressure off of the cord, clamp and cut cord when unable to manually reduce.
  - If umbilical cord seen, elevation of presenting part with vaginal hand and maintain elevation until delivery via C-section AKA “ride the bed” ***Do not place pressure on the cord or monitor pulse via the cord.
  - Suctioning of nose and mouth with bulb aspirate recommended if obvious obstruction from secretions.
  - Use slight downward pressure to deliver superior shoulder, then slight upward pressure to deliver lower shoulder.
  - Clamp cord after 1-3 minutes with 2 hemostats and cut between clamps.
  - Immediately wrap infant and give to mother – assistant to aid in monitoring child.
  - Deliver placenta – should feel lengthening / giving way of cord and gush of blood – keep placenta for pathology evaluation. (This process may take up to 30min. Never pull on the umbilical cord in attempts to speed delivery.)
  - “Externally” massage uterus to encourage contraction and limit bleeding.
  - If neonate appears to be stuck in the birth canal (i.e., turtling of the head), flex the mother’s hips (both knees to chest) in order to widen the birth canal.
  - Provide the neonate with safe and adequate hearing protection and hypothermia prevention as possible.

NEWBORN CARE & DISTRESS

Continued from:
- **TACTICAL EVACUATION Guideline,**
- **CHILDBIRTH Guideline, or**
- **Pediatric RESPIRATORY DISTRESS Guideline**

Maintain:
Universal Patient Care Guideline
(Mother and Newborn)

- **Airway Open?** (Breathing or Crying)
- **Good Tone?**
- **Full Term Delivery?**

YES → **Post Resuscitation Care**
- Clear Airway (bulb syringe mouth / nose)
- Dry Infant
- Keep Warm (wrap in blanket)
  - Avoid Hyper / Hypothermia
- Determine APGAR Score
- Treat Hypoglycemia (Glucose <40)
- Continuous Monitoring (with SpO_2)

NO

- Clear Airway (Bulb syringe Mouth / Nose)
- Dry Infant
- Stimulate (Foot Tap, Back Rub)
- Keep Warm (wrap in dry blanket)
- SpO_2 Monitor (if not already placed)
- Determine APGAR Score

- **HR <100?**
- **Apnea or Gasping?**
- **Labored Breathing?**
- **Persistent Cyanosis?**

NO → **Post Resuscitation Care**

YES

- Clear Airway
- **BVM (PPV): Titrate to 94-99% SpO2 at 30-60 breaths/min**
- SpO_2 Monitoring

HR <100? — **NO** → **Post Resuscitation Care**

YES

Take Ventilation Corrective Steps
(Intubate if NO Chest Rise)

HR <60? — **NO**

YES

- **Chest Compressions with PPV**
  (120 events/min: 90 compressions interspersed with 30 ventilations)
- **Consider Intubation**

HR <60? — **NO**

YES → **Epinephrine 1:10,000**
0.01-0.03mg/kg push q3-5min
(0.1-0.3mL of 1:10,000
10cc Cardiac Epi vial)

Consider:
1. **Hypoglycemia** (Treat Glucose <40)
2. **Shock**
3. **Pneumothorax** (Intubate)

1. **D12.5 1.0mL/kg IV** (Dilute D50 to ¼ strength (1mL D50 in 3mL NS)
2. **IVF or Blood 10mL/kg IV**
3. **Intubation**

Meconium Staining of Amniotic Fluid?
- Suction Mouth then Nose until clear with bulb syringe. Deep suction is no longer advised.

Targeted Preductal SpO_2 After Birth

1 min: 60-65%
2 min: 65-70%
3 min: 70-75%
4 min: 75-80%
5 min: 80-85%
10 min: 85-95%

Do NOT titrate O_2 for SpO_2 >95%

Signs of:
Dehydration
- Tachycardia, ↓BP
- Sunken Fontanelles
- No tears
- Dry mouth, tongue, skin
- ↓UOP

Fluid Overload
- Shortness of Breath
- Ankle / Sacral Edema
- ↑Jugular venous pressure
- Crackles in Lungs

APGAR SCORE
- Determine by end of 1st 60 seconds of care and repeat every 5 min.
- Score of 6 or less? Start Immediate Resuscitation.

(CPR: **90 compressions per 30 ventilations / min** – provide supplemental O_2 to titrate to 94-99%SpO2)

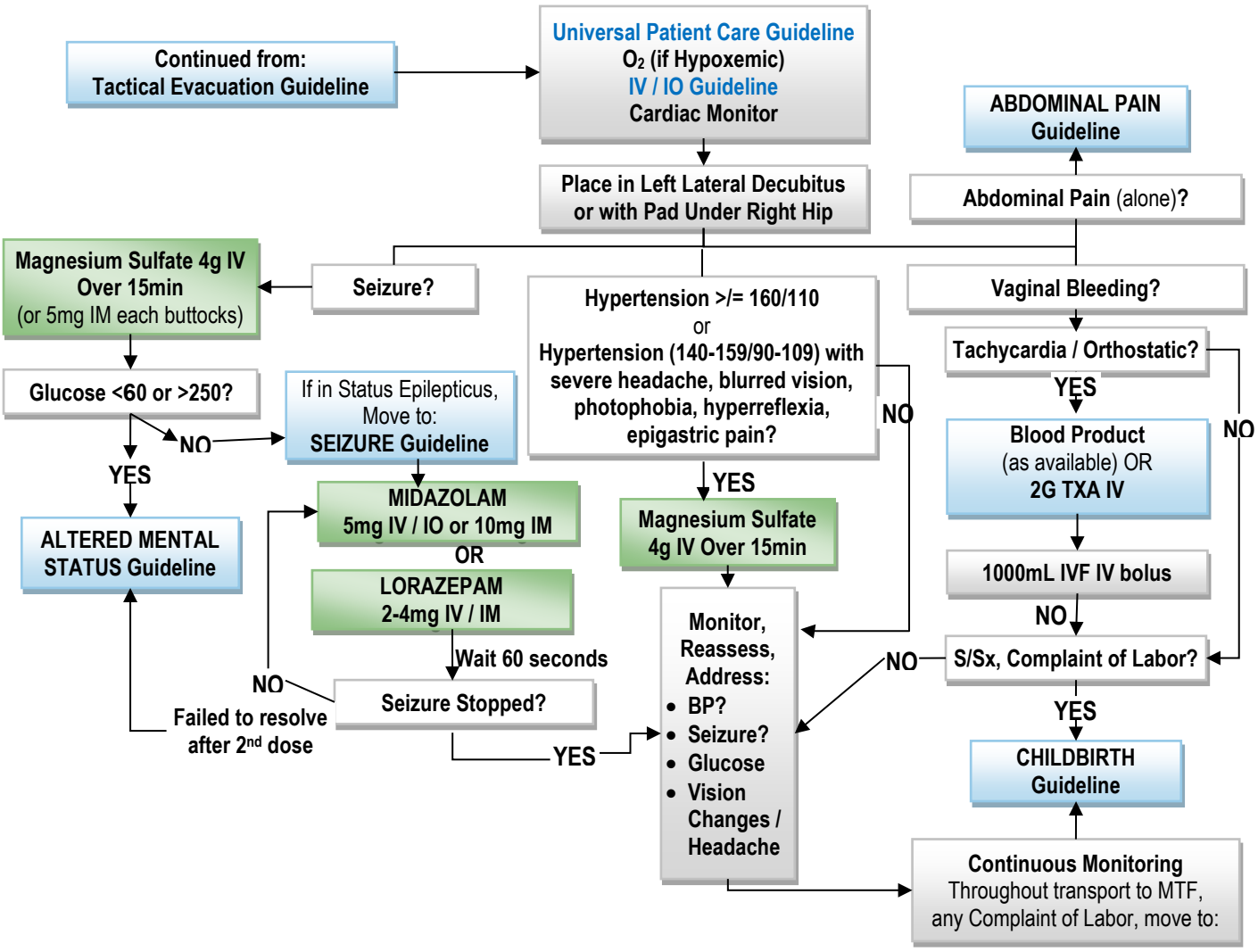
APGAR SCORING	0 POINTS	1 POINT	2POINTS	SCORE
Activity (Muscle Tone)	Absent	Arms and Legs Flex	Active Movement	
Pulse	Absent	Below 100 bpm	Over 100 bpm	
Grimace (Reflex irritability)	Flaccid	Some Extremity Flexion	Active motion (pull away, cough)	
Appearance (Skin color)	Blue, Pale	Body Pink, Extremities blue	Completely Pink	
Respirations	Absent	Slow, irregular	Vigorous cry	
			TOTAL APGAR:	

Severely Depressed	**0-3**
Moderately Depressed	**4-6**
Excellent Condition	**7-10**

OBSTETRIC EMERGENCY

Signs and Symptoms:
- Vaginal Bleeding
- Abdominal Pain
- Seizure
- Hypertension
- Headache
- Visual Disturbance

Differential Diagnosis:
- Pre-Eclampsia / Eclampsia
- Placenta Previa
- Abruptio Placentae
- Spontaneous Abortion



Pearls:
- Seizure / headache / vision complaints: can give Midazolam 0.1mg/kg IV every 15-30 or 1mg IV every2-3min up to 5mg while waiting for magnesium to take effect.
- Seizure activity in an OB patient signifies eclampsia.
- The best life support for the fetus is to resuscitate the mother.
- All pregnant / suspected pregnant patients should be kept in the left lateral decubitus position or have padding placed below the right hip to keep pressure off of the inferior vena cava.
- Use caution when using magnesium – it can lead to cardiorespiratory collapse with hypotension and decreased respiratory drive.
- Treat all hypertensive patients as if they are pre-eclamptic despite any prior history of hypertension.
- The leading cause of Postpartum Hemorrhage is Uterine Atony (lack of contracting), which can be treated with uterine massage

TREATMENT OF MINORS

INDICATIONS:

Responding to treat a minor patient without a parent or legal guardian representative available. For the purpose of these guidelines, all patients under age 18 years will be considered minors. Medical aircrew and medical directors should consult unit rules of engagement and applicable laws and adjust accordingly.

PATIENT MANAGEMENT PROCEDURE:

1. Treatment and transport of any minor requiring immediate care to save a life or prevent severe injury will be performed following the principle of implied consent for emergency care. (Assume any minor who needs treatment to save life, limb, eyesight, or to prevent severe injury has provided consent to treatment.)

2. **ALWAYS** act in the patient's best interest. **ALWAYS** maintain complete and careful documentation.

3. If the parent or guardian is present, follow these guidelines:
    a. Allow one (1) parent to accompany the child during transport after approval of the pilot in command (PC) **and** if it does not interfere with patient care or flight safety.
    b. In event of major trauma and/or cardiac arrest, judgment should be exercised in allowing parents to accompany the child. Recent evidence supports this practice in emergency departments and some EMS settings, but care should be exercised to maintain crew safety and mission accomplishment.
    c. Allow the parent to hold or touch the child, if possible, while assuring optimal transport restraints to assure safety.
    d. Remember to be open and honest to both parent and child about the child's condition and any treatment given. **DO NOT** diagnose, **DO NOT** deceive, and **DO** try to comfort the child and parent.

4. In many jurisdictions, parent or legal guardians **CANNOT** refuse consent for treatment/transport of a minor with a life-threatening condition. Contact your medical director in the event of the parent/guardian refusing treatment/transport of a minor with a life-threatening condition.

SEXUAL ASSAULT

INDICATIONS:

1. Reported and/or suspected assault on any person regardless of age or gender.
2. Trauma and/or bleeding to the vagina, rectum or buttocks that cannot be identified as being the result of any other cause.

REMARKS:

1. Focus shall be placed on the victim and on doing what is necessary and appropriate to support victim recovery and also, if a Service Member, to support that Service Member to be fully mission capable and engaged.
2. Medical personnel should be gender-responsive, culturally competent, and recovery-oriented.
   a. Medical providers giving care to sexual assault victims shall recognize the high prevalence of pre-existing trauma (prior to present sexual assault incident) and the concept of trauma-informed care.
   b. If the attending flight medic is not appropriately trained to utilize a Sexual Assault Forensic Evidence (SAFE) Kit, information will be forwarded to the Medical Treatment Facility in order to make the necessary arrangements to complete the SAFE Kit administration as soon as possible.
3. Flight Paramedics shall abide by the Sexual Assault Prevention and Response (SAPR) Program and coordinate with the Sexual Assault Response Coordinator (SARC) and Sexual Assault Prevention and Response Victim Advocate (SAPR VA). The SARCs shall serve as the single point of contact for coordinating care to ensure that sexual assault victims receive appropriate and responsive care.
4. Sexual assault victims shall be given priority and treated as emergency cases. Emergency care shall consist of emergency medical care and the offer of a SAFE Kit.

PATIENT MANAGEMENT PROCEDURE:

1. In the management of sexual assault patients, the DoD's first priority for victims is to protect, treat with dignity and respect, and to provide the medical treatment, care, and counseling that patients deserve. Under the DoD Confidentiality Policy, sexual assault victims have two reporting options: Restricted and Unrestricted. It is mandatory that all DoD health care providers (including 68Ws) adhere to the parameters of confidentiality and notification pursuant to each form of reporting.

   a. **Restricted Reporting**: Reporting option that allows assault victims to confidentially disclose the assault to specified individuals (e.g., SARC, SAPR VA, healthcare personnel) and receives medical treatment (including emergency care), counseling, and assignment of a SARC and SAPR VA; without triggering an investigation. The victim's report provided to healthcare personnel (including the information acquired from a SAFE Kit), SARCs, or SAPR VAs will NOT be reported to law enforcement or to the command to initiate the official investigative process unless the victim consents or an established EXCEPTION applies. Restricted reporting applies to Service Members and their military dependents 18 years of age and older. Additional persons who may be entitled to Restricted Reporting are NG and Reserve Component members. Only a SARC, SAPR VA, or healthcare personnel may receive a Restricted Report.

   b. **Unrestricted Reporting:** A process that an individual covered by this policy uses to disclose, without requesting confidentiality or Restricted Reporting, that he or she is the victim of a

sexual assault. Under these circumstances, the victim's report provided to healthcare personnel, the SARC, a SAPR VA, command authorities, or other persons is reported to law enforcement and may be used to initiate the official investigative process.

5. Priority treatment as emergency cases includes activities relating to access to healthcare, coding, and medical transfer of evacuation and complete physical assessment, examination, and treatment of injuries including immediate emergency interventions.
6. **DO NOT** attempt to examine the patient without informed consent except to treat immediate life, limb, or eyesight threats. SARC notification must not delay emergency medical care treatment of a victim.
    a. Limit cleaning of wounds to only determine severity.
    b. Check for associated or additional injury and/or other illness. Refer to appropriate medical treatment guidelines as appropriate.
7. In situations where installations do not have SAFE kit capability, the installation commander will require that the eligible victim, who wishes to have a SAFE, be transported to a MTF or local off-base, non-military facility that has a SAFE capability. A local sexual assault nurse examiner or other healthcare providers who are trained and credentialed to perform a SAFE may also be contacted to report to the MTF to conduct the examination.
8. Preserve all evidence:
    a. Bag all personal items (e.g., blood stained items, clothes). Paper bags are recommended if available, in order to prevent excess moisture accumulation and subsequent evidence degradation.
    b. Ensure all items are signed for before handing off.
    c. Ensure all interactions, statements made by the patient, and all treatment given is medically documented in patient care record while maintaining patient confidentiality.

PATIENT REFUSAL

INDICATIONS:

If a patient (or person[s] responsible for a minor) refuses treatment or transport, after pre-hospital providers have arrived on the scene, the following procedures should be carried out:

PATIENT MANAGEMENT PROCEDURE:

1. A Primary Assessment (to include vital signs) should be completed, if possible. Pay particular attention to the patient's mental status.

2. Any injuries or illnesses found to immediately threaten life, limb, or eyesight (or can be assumed will deteriorate enroute) should be addressed and treated immediately while enroute, to the greatest extent possible while assuring safety. With Patients that prevent treatment of these injuries, all should be done to encourage the patient seek treatment and any doubt of capacity should prompt treatment/transport under implied consent. Patient with decision-making capacity refusing treatment of life-threatening injury or illness require further clinical judgement and consultation with medical director prior to informed refusal.

3. Injuries or illnesses that do not represent imminent threats to life, limb, or eyesight (or considered unlikely to deteriorate enroute) may be addressed in accordance with the following:

   a. Determine the patient's (or parent's) decision-making capacity to make sound/ valid judgments concerning the patient's condition. If there are any doubts from the provider's aspect, consider treating in accordance with the **ALTERED MENTAL STATUS GUIDELINE** or **COMBATIVE PATIENT GUIDELINE.** Decision-making capacity means that:
      - The patient is awake, alert, and oriented to person, place, time and event.

        AND
      - The patient is able to understand his/her medical problem(s), and recite back an understanding of the medical problem(s) and risks of possible resulting problems or worsening of his/her medical condition if patient is not evaluated and treated.
   b. Ensure that you clearly and repeatedly explain to the patient or responsible parties of the concerns and possible risks involved in refusing medical care.
   c. Clearly document all findings during the patient assessment and any discussions with the patient regarding his/her condition as well as all persons involved with the patient. Document all statements made pertaining to the risks associated with refusing treatment and transportation and obtain a signature from a witness (crewmember) and the patient or parties responsible for the patient as to refusal of care.
   d. Clearly explain to **Military Personnel** why the treatment is needed**. Notify them that refusal of treatment may bring judicial or administrative adverse action upon them under UCMJ.**

SAMPLE PATIENT REFUSAL

DATE:_____

PATIENT REFUSAL FORM

PATIENT INFORMATION:

_____ _____ _____

LAST NAME FIRST NAME M.I.

_____

ADDRESS

_____ _____ _____

D.O.B / AGE SSN / DOD ID UNIT

_____

GUARDIAN / CARE GIVER

WAIVER OF LIABILITY:

I REFUSE TREATMENT AND/OR TRANSPORTATION BY THE PROVIDING MEDICAL SERVICE. I ASSUME RESPONSIBILITY FOR MY OWN, MY CHILD'S OWN, OR FAMILY MEMBER'S MEDICAL TREATMENT. I RELEASE THIS MEDICAL SERVICE FROM ANY LIABILITY OR MEDICAL CLAIMS RESULTING FROM MY REFUSAL OF EMERGENCY MEDICAL CARE AND/OR TRANSPORTATION.

I HAVE BEEN ADVISED:

☐ TO SEEK MEDICAL CARE OF A PHYSICIAN. (INITIALS_____)

☐ REFUSING MEDICAL CARE AND/OR TRANSPORTATION AGAINST MEDICAL ADVISEMENT CAN LEAD TO WORSENING OF MY CONDITION AND/OR A FATAL OUTCOME. (INITIALS_____)

☐ DIFFERENTIAL DIAGNOSIS:_____

☐ VITALS: BP:_____ HR:_____ RR:_____ SPO2:_____ GCS:_____

☐ I AM MAKING THIS REFUSAL IN GOOD MENTAL CAPACITY AND JUDGEMENT. (INITIALS_____)

_____ _____

PATIENT / GUARDIAN SIGNATURE WITNESS SIGNATURE

_____ _____

FLIGHT MEDIC SIGNATURE ADDITIONAL WITNESS SIGNATURE

COMBATIVE PATIENT

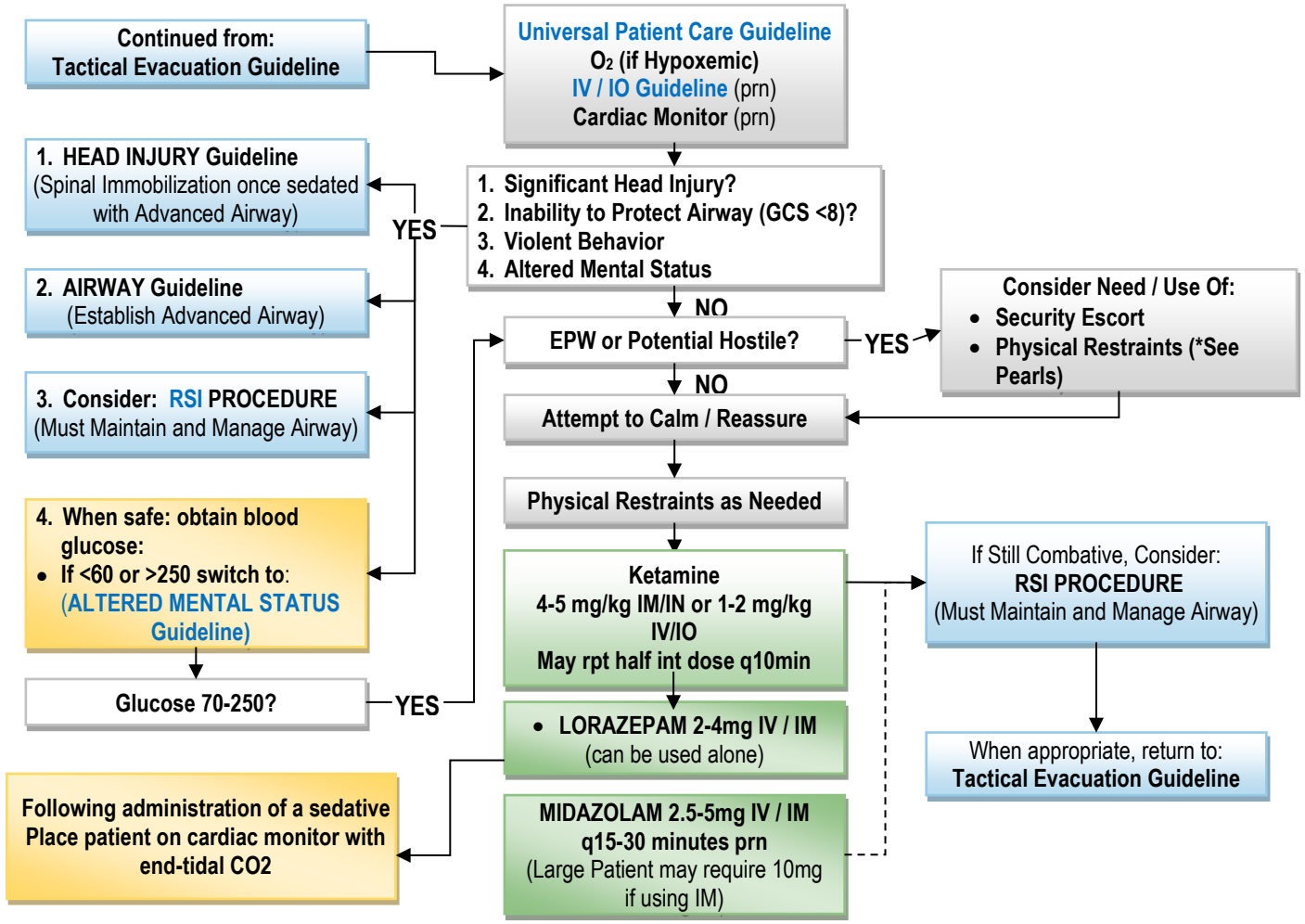
Signs and Symptoms:

- Bizarre Behavior
- Violent Activities
- Head Injuries / AMS
- Anxiety
- Tachycardia / Elevated BP

Differential Diagnosis:

- Head Trauma / Psychiatric Disorders
- Thyroid Dysfunction
- Hyper/Hypoglycemia
- Diabetic Ketoacidosis / Toxic Ingestion
- Environment (Hyper / Hypothermia)
- Hypoxia

Safety of Helicopter/Crew/other patients is first priority


Continued from:
Tactical Evacuation Guideline
Universal Patient Care Guideline
O2 (if Hypoxemic)
IV / IO Guideline (prn)
Cardiac Monitor (prn)
1. HEAD INJURY Guideline
(Spinal Immobilization once sedated with Advanced Airway)
2. AIRWAY Guideline
(Establish Advanced Airway)
3. Consider: RSI PROCEDURE
(Must Maintain and Manage Airway)
4. When safe: obtain blood glucose:
• If <60 or >250 switch to:
(ALTERED MENTAL STATUS Guideline)
Glucose 70-250?
YES
1. Significant Head Injury?
2. Inability to Protect Airway (GCS <8)?
3. Violent Behavior
4. Altered Mental Status
YES
NO
EPW or Potential Hostile?
YES
NO
Consider Need / Use Of:
• Security Escort
• Physical Restraints (*See Pearls)
Attempt to Calm / Reassure
Physical Restraints as Needed
Ketamine
4-5 mg/kg IM/IN or 1-2 mg/kg IV/IO
May rpt half int dose q10min
• LORAZEPAM 2-4mg IV / IM
(can be used alone)
MIDAZOLAM 2.5-5mg IV / IM
q15-30 minutes prn
(Large Patient may require 10mg if using IM)
If Still Combative, Consider:
RSI PROCEDURE
(Must Maintain and Manage Airway)
When appropriate, return to:
Tactical Evacuation Guideline
Following administration of a sedative
Place patient on cardiac monitor with end-tidal CO2

Pearls:

- ***Physical restraints** such as tying down patient hands to prevent pulling lines, etc., should be limited to the least amount necessary to accomplish treatments / prevent injuries. **(Kerlex gauze can be a useful restraint)**
  - **Do not jeopardize the patient's airway!** – Avoid hog tying, lying prone in restraints, sandwiching between spine boards, etc.
  - **Check Vitals, SpO_2, Pulse and Cap Refill every 5 minutes.**
- Combative patients present a very real threat to the safety of themselves, the medic, and the aircrew during flight. For this reason, any patient with altered mental status and the potential for combativeness that would threaten aircrew safety or themselves should be prophylactically sedated / paralyzed and intubated for the flight.
- Use of sedative medications adds risk of decreasing respiratory drive and should be used with caution. However, meds should be titrated to adequate dosage to control patient. Be prepared for airway interventions/vomiting if used. Cardiac arrest in patients with excited delirium/extreme agitation following restraint is well documented. Capnography in addition to cardiac monitoring is essential.

MWD Normal Clinical Parameters

for further reference see

Clinical Practice Guidelines for Military Working Dogs, 12 Dec 2018

Vital Signs

- **Temperature (rectal)- 99.5° to 103° F**
- **Heart Rate/ Pulse- 60 to 80 (at rest) bpm**
- **Respiratory Rate- 16 to 32 bpm**
  (Controlled panting is normal**)**
- **Blood Pressure- Systolic 120 mmHg, Diastolic 80 mmHg, Mean 90 to 100 mmHg**

Clinical Pearls for MWDs-

- Average MWD weighs 30-35 kg (German shepherd dogs, Belgian Malinois, Labrador retrievers).
  All drug dosages should be calculated based on measured or estimated body weight.
  DOG HANDLER CARRIES DRUG CARD FOR THE DOG
- IV catheterization access points are:
  - Cephalic vein on the cranial (superior) aspect of the forearm (figures 1 & 2)
  - Lateral saphenous vein on the lateral aspect of the hind limb at the distal tibial area (figure 3)
  - External jugular vein in the jugular furrow of the neck. Standard human central venous catheter kits can be used; the Seldinger technique is most reliable.
- IO catheterization access points are:
  - Greater trochanter of the humerus (figure 4 & 5)
  - Medial tibia just distal to tuberosity (figure 6 & 7)
- Arterial Pulse is palpated at the femoral artery on the medial aspect of the proximal thigh in the inguinal area (figure 8) or at the dorsal metatarsal artery on the dorsal aspect of the proximal hind paw.
- Heart sounds are best auscultated over the lower left lateral thoracic wall between the 4th and 5th intercostal space. (figure 9)
- 3-lead electrocardiograms are sufficient for MWDs. Adhesive electrodes should be taped to the pads of the paws of the left forelimb (**black** lead), right forelimb (white lead), and left hind limb (**red** lead). (figure 10)
- Pulse oximetry probes can be utilized on conscious dogs using the ear pinna, lip fold, or flank skin; while not optimal for oximetry, these alternative sites are generally acceptable. For optimal reliability place probe on tongue (only in unconscious dogs)

Figure 1- Vein best punctured toward the elbow.

Figure 2- Vein occlusion superior to elbow joint while elbow is in extension.

Figure 3- lateral saphenous vein on the hind limb of a MWD

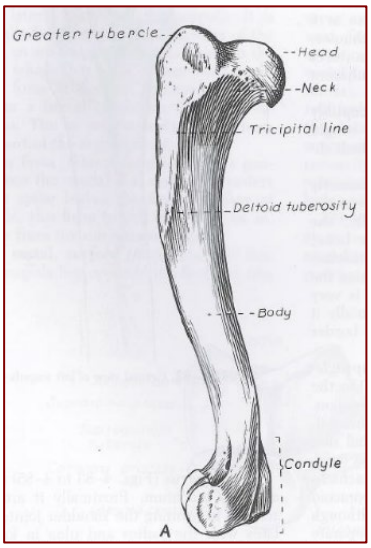


Figure 4 - Musculoskeletal view of greater trochanter of the humerus for IO catheter

Figure 5 - Shoulder IO catheter location

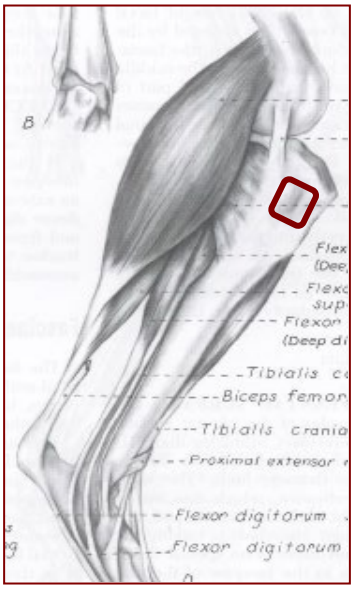


Figure 6 - Musculoskeletal view of medial tibia location for IO catheter just distal to tuberosity

Figure 7 - medial tibia IO catheter location just distal to tuberosity

Figure 8 - location for palpation of the femoral arterial pulse

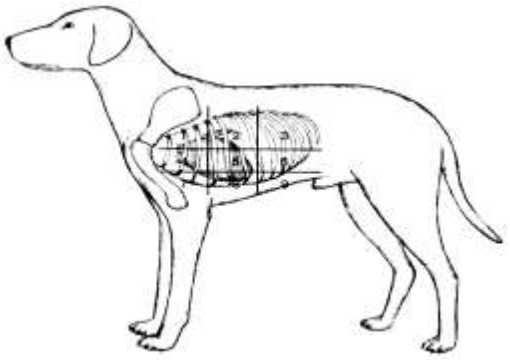
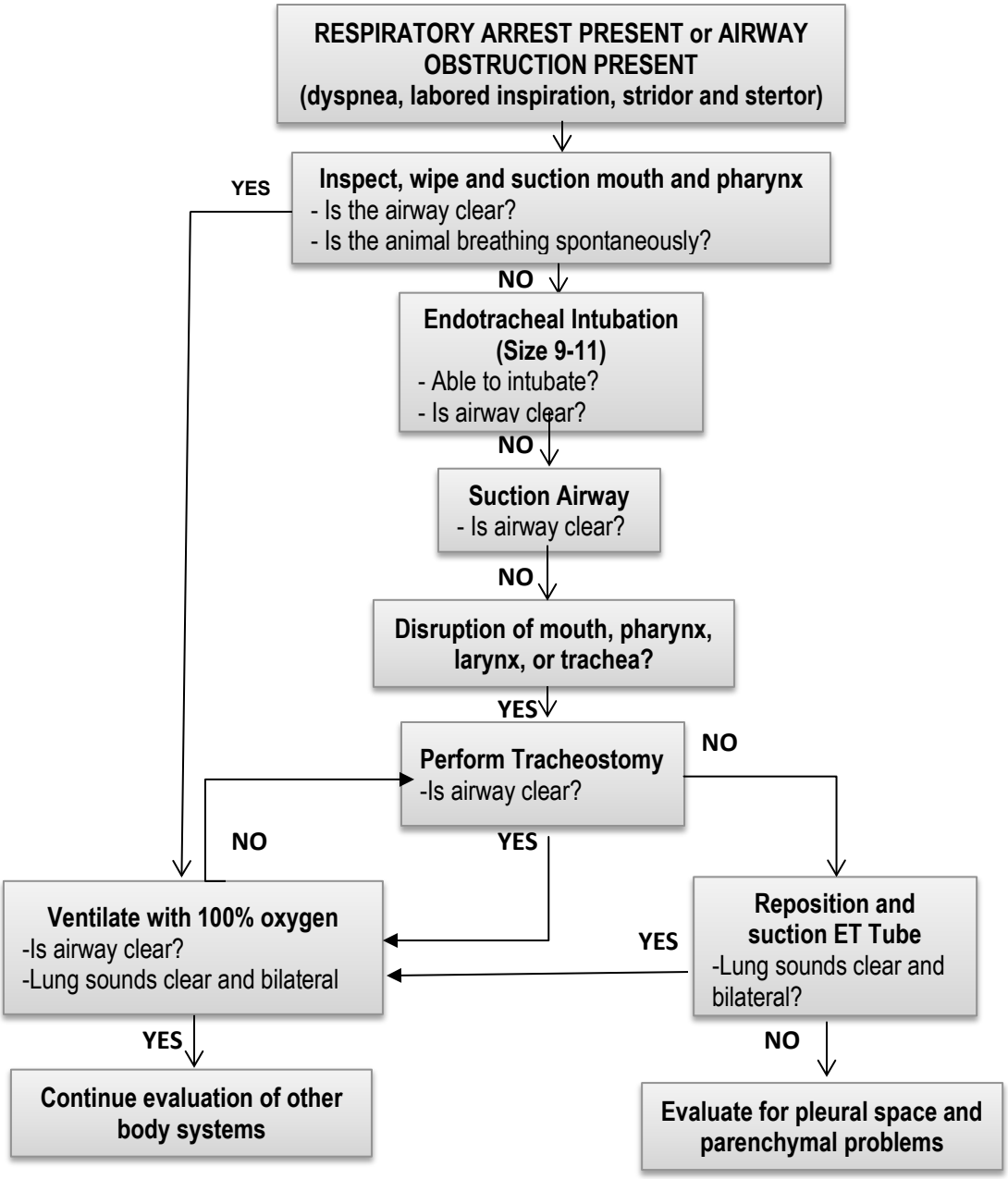


Figure 9 - optimal location for auscultation of the heart sounds and palpation of the heart beat

Figure 11- placement of pulse oximetry on tongue

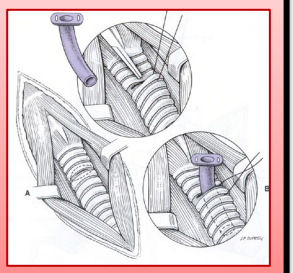
Figure 10 - placement of adhesive ECG electrode pads on the footpads

MWD Airway Management



100% Oxygen Supplementation Examples

Conscious or fractious muzzled dogs (10-15 L/min)



Orotracheal intubation or Tracheostomy (2 L/min)

Clinical Pearls:

- Unconscious MWDs: Use tracheal insufflation, orotracheal intubation, or tracheostomy. If there is an obstruction then bypass the obstruction until the patient is more stable. Do not use tracheal insufflation for >30 min.

- NOTE: intubation of the MWD is most easily performed with the dog in sternal or prone position, head and neck extended, and tongue pulled forward. Verify placement by palpating neck for 1 tube. If 2 tubes are felt, the tube is in the esophagus. Capnometer reading > 10mmHg also ensures correct placement.

MWD Heat Injury Treatment

MILD heat injury (heat stress) - excessive thirst, discomfort associated with physical activity, mild dehydration, but with controlled panting (i.e., the patient can control or reduce panting when exposed to a noxious inhalant such as alcohol).

↓

-Remove patient from source of heat, discontinue exercise, cool by fans or air condition, give cold water to drink.

↓

-Monitor patient for
- Body Temp every 15 mins
- Mentation / LOC
- Weakness / collapse
- Anxiety/ restlessness
- Shock

MODERATE heat injury (heat exhaustion) - heat stress present, as well as weakness, anxiety, and uncontrolled panting (i.e., the patient cannot reduce panting when exposed to a noxious inhalant), but central nervous system (CNS) abnormalities are not present.

↓

-Same as MILD but more aggressive cooling required Remove patient from all heat and stop all activity.

↓

-Cool by fans or air condition.
-Thoroughly soak the hair coat to the skin (room-temp) in order to reduce core body temperature < 105F.
-Give IV fluids 3-5 mL/kg/hr if not in shock

↓

-Monitor patient for
- Body Temp every 15 mins
- Mentation / LOC
- Petechiae / ecchymoses
- Weakness / collapse
- Anxiety/ restlessness
- Shock

SEVERE heat injury (heat stroke) – heat exhaustion are present, coupled with varying degrees of CNS abnormalities (changes in mentation and level of consciousness, seizures, abnormal pupil size, blindness, head tremors, and ataxia.

↓

-Triage-
- Establish airway
- Provide oxygen
- Establish IV for shock treatment

↓

-Aggressively cool patient until rectal temp is less than 105°F.
- Use only room temperature fluids.
- Give IV fluids (shock protocol)

↓

-Monitor patient for
- Vitals, Blood Glucose
- ECG arrhythmias
- Mentation / LOC
- Gait abnormalities
- Vision changes
- Seizure
- Rebound hypothermia

Clinical Pearls:

- **PANTING** is the only significant cooling mechanism for dogs.
- **NO** specific body temperature defines heat stroke in MWD's. Normal rectal temperature is 101° to 103° F in the MWD. Temperatures as high as 105.8°F have been associated with pathology. Most commonly, heat stroke is seen in MWDs with rectal temperatures greater than 107°F.
- **DO NOT** use of cold intravenous fluids, ice packs, or ice-water baths for cooling.
- Once the MWD's body temperature is =103°F **CEASE** all cooling efforts and monitor for rebound hypothermia, and prepare for rewarming measures. Actively warm the dog if the temperature <100°F
- Treat seizures with midazolam or diazepam 0.3 mg/kg IV, IO or Intranasal prn

MWD CPR Management

Cardiopulmonary Arrest Confirmed

BEGIN BASIC LIFE SUPPORT- SUSTAIN CPR for 2-3 minute cycles

- **Circulation-** Chest compressions, FAST and HARD, 100 compressions per minute
- **Airway-** Clear airway and intubate; perform tracheostomy if obstructed airway
- **Breathing-** Manually ventilate with 100% O_2 at 8-10 breaths per minute

BEGIN ADVANCED LIFE SUPPORT
ECG (determine arrest rhythm)
IV / IO access for drug delivery

VF or VT

- Defibrillate- **2-5 J/kg** biphasic
- Resume chest compressions x 1 cycle (2 min)
- Defibrillate twice more, with 1 compression cycle between each counter-shock, if refractory
- Drug therapy if counter-shock no successful:
  - Epinephrine **0.01 mg/kg** IV/IO
    or
    Vasopressin **0.8 U/kg** IV/IO **once**
    and
  - Lidocaine **2 mg/kg** IV/IO
    or
  - Amiodarone **5-10 mg/kg** IV/IO
- Repeat counter-shock (50% INCREASED initial energy) if refractory

ASYSTOLE/ BRADYCARDIA/ PEA

- Drug therapy:
  - Atropine **0.04 mg/kg** IV/IO *only if bradycardia preceded arrest*
  - Epinephrine **0.01 mg/kg** IV/IO
    and
    Vasopressin **0.8 U/kg IV/IO once**

CPR Emergency Drugs and Doses

	DRUG	DOSE	Weight (kg)	2.5	5	10	15	20	25	30	35	40	45	50
			Weight (lb)	5	10	20	30	40	50	60	70	80	90	100
				ml	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml
Arrest	Epi Low (1:1000)	0.01 mg/kg		0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Arrest	Epi High (1:1000)	0.1 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Arrest	Vasopressin (20 U/ml)	0.8 U/kg		0.1	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2
Arrest	Atropine (0.54 mg/ml)	0.05 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhyth	Amiodarone (50 mg/ml)	5 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Anti-Arrhyth	Lidocaine (20 mg/ml)	2-8 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reversal	Naloxone (0.4 mg/ml)	0.04 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reversal	Flumazenil (0.1 mg/ml)	0.01 mg/kg		0.25	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
Reversal	Atipamezole (5 mg/ml)	50 ug/kg		0.03	0.05	0.1	0.15	0.2	0.25	0.3	0.35	0.4	0.45	0.5
Defib Monophasic	External Defib (J)	2-10 J/kg		20	30	50	100	200	200	200	300	300	300	360
Defib Monophasic	Internal Defib (J)	0.2-1 J/kg		2	3	5	10	20	20	20	30	30	30	50
Defib Biphasic	External Defib (J)	2-4 J/kg		6	15	30	50	75	75	100	150	150	150	150
Defib Biphasic	Internal Defib (J)	0.2-0.4 J/kg		1	2	3	5	6	8	9	10	15	15	15

Reprinted with permission from the Veterinary Emergency & Critical Care Society (veccs.org) RECOVER Initiative CPR Emergency Drugs and Doses chart.

Clinical Pearls:

- 70% of MWDs that arrest will have PEA, asystole, or sinus bradycardia as the initial arrest rhythm. Epinephrine or vasopressin are best choices for these rhythms or for empiric use if ECG capability is not available

- Avoid interrupting chest compressions! The key to successful resuscitation is to SUSTAIN chest compressions aggressively for 2-3 minutes before stopping to check status.

- Most people apply too little force when performing chest compressions! Do not be concerned with breaking ribs or injuring the heart or chest with BLS. In contrast to CPR in people, the thorax of MWDs is more compliant and fractures are rare

MWD Analgesia and Sedation

Sedation Protocols in the Military Working Dog

MWDs may become fractious during flight and chemical restraint by intramuscular injection will likely be required to facilitate IV catheter placement and treatment of a conscious MWD

MILD SEDATION

- **INDICATION**: Relax MWD for examination, handling, reducing anxiety
- **PROTOCOL:** Midazolam 0.3 mg/kg IM AND Hydromorphone 0.2 mg/kg IM
  - **Hydromorphone 0.2mg/kg IM may be substituted for morphine**
- **EXPECTATION:** MWD will be calm, but reactive and noise sensitive

DEEP SEDATION

- **INDICATION**: First line protocol for fractious MWD
- **PROTOCOL:** Midazolam 0.3 mg/kg AND Ketamine 5 mg/kg AND Hydromorphone 0.1 mg/kg IM
  - **Hydromorphone 0.1 mg/kg may be substituted for morphine IM**
- **EXPECTATION:** The MWD will not be able to walk but cannot be intubated. MWD may be aroused with significant stimulation and maintains laryngeal and palpebral reflexes

If MWD is suspected of having PAIN or PAIN is anticipated, please provide analgesia

Intermittent IV or IM supplementation

Or

Hydromorphone 0.1-0.2 mg/kg q 2-4 hours

Morphine Sulfate 0.2-0.5 mg/kg q 4-6 hours

- IV catheter (discretional)
- Give Midazolam 0.3 mg/kg IM & Hydromorphone 0.2 mg/kg IM q 2-4 hours

Continuous Infusion

Or Or

Fentanyl 2-10 mcg/kg/hour

Morphine 0.1-0.25 mg/kg/ hour

Hydromorphone 0.02-0.05 mg/kg/hour

- Place IV catheter once the MWD is controlled
- Give Midazolam 0.3 mg/kg IM & Ketamine 2 mg/kg IM & Hydromorphone 0.1 mg/kg IM
- Can also use Propofol in 1 mg/kg boluses IV as needed to allow catheterization or intubation

Clinical Pearls:

- Dosages for analgesics in dogs are significantly higher than for people.
- Assessment of pain in dogs is difficult. Health Care Providers should err on side of providing analgesia. Properly performed, it is safe and effective, and analgesia is critically important for safe handling and alleviation of pain.
- Note that all protocols have analgesia incorporated into them. Additional analgesia can be provided by the IV/IM or PO route, as necessary.
-Opioids cause emesis, usually within 5 minutes of administration. Be prepared to remove the muzzle to minimize aspiration risk. Hydromorphone causes excessive panting; use caution with head injuries, GDV, and respiratory disease.

- **CAUTION: Do NOT use acetaminophen or ibuprofen in MWDs, as these drugs can cause liver toxicity. AVOID use of NSAIDs such as naproxen and aspirin in emergently ill or injured MWDs.**
- **OPIOID REVERSAL:** At appropriate doses, dogs appear less susceptible to opioid-induced respiratory depression and excessive sedation. However, opioid side effects can be reversed in the dog using NALOXONE 0.01-0.02 mg/kg slow IV to effect if needed. **Note that this will reverse analgesia as well as sedation!**

MWD Gastric Dilation-Volvulus

GDV is a **rapidly life-threatening** condition common in MWDs. In GDV, the stomach rapidly dilates (gastric dilation) with fluid, food, and air, and then rotates along the long axis (volvulus) and causes shock by interfering with venous return from the abdomen and pelvic limbs.

Clinical Signs:
- varying degree of abdominal distention/tympany, non-productive retching, attempted vomiting without result; signs of pain (grunting when palpating stomach); signs of anxiety; inability to lay comfortably; and signs of compensatory shock (tachycardia, tachypnea)

Initiate Monitoring:
ECG, NIBP, SpO_2, $ETCO_2$, Evaluate for dysrhythmias, hypotension, hypoxemia, hypo- or hypercapnia

Treat Shock
- Give supplemental O_2
- Place at least 2 IV or IO catheters in the forelimbs (preferably one central)
- Give IV or IO crystalloid therapy utilizing the **10-20-10-10** fluid guideline
- Give **hydroxyethyl starch** (**HES**) boluses (10-20 mL/kg) IV or IO as needed to maintain normal blood pressure. Repeat this bolus if no response to therapy.
- Give **hypertonic saline (HTS)** IV bolus of 4 mL/kg over 5 minutes (if 7-7.5% HTS is available) for MWDs that fail to respond to two or three quarter-shock boluses of crystalloids and/or one or two boluses of HES.

Decompress the Tympanic Stomach
- Position self on left side, or lay dog on left side
- Locate Insertion point: Palpate last rib, move hand two inches caudal to the last rib, midway between the spine and the ventral border of the abdomen on the right side, auscultate the lateral abdominal wall at most distended area while percussing the wall with a finger. Loudest "ping" is the site of insertion.
- Clip hair over a 6-inch area over the area.
- Prepare area with a surgical scrub.
- Forcefully insert 14-18 gauge IV over-the-needle catheter through the skin, abdominal wall, and stomach wall.
- Note gas or air escaping through the needle from the stomach to signify a successful attempt. .
(**DO NOT ATTEMPT SECOND INSERTION** if first is unsuccessful)
- Apply gentle external pressure to abdominal wall to assist exiting air.
- Remove catheter once air is evacuated.

Provide analgesia utilizing analgesia guideline

Clinical Pearls:

Goal is to treat for shock, decompress stomach, and transport for surgical intervention.

Monitor for ventricular arrhythmias, persistent shock and recurrent dilation

Surgery is REQUIRED for definitive treatment to derotate the stomach.

MWD Shock Fluid Therapy

The "10-20-10-20 Rule"

Shock Fluid Therapy Protocol of MWDs

- Place multiple large-bore intravenous catheters, perform venous cut-down, and/or place intra-osseous (IO) catheters. Provide flow-by supplemental oxygen therapy.

- Give IV or IO crystalloid therapy utilizing the 10-20-10-10 fluid guideline:

1. Calculate total fluid "shock" volume (**90 mL/kg**) that might be required.
2. Collect baseline physiologic and clinical data (mentation, NIBP, HCT, TP, HR, pulse quality, CRT, mucous membrane color).
3. Give one quarter of the calculated "shock" volume over the first **10** minutes.
4. Reassess the patient's pulse quality, CRT, mucous membrane color, heart rate, NIBP, etc.
5. Give another one quarter of the calculated "shock" volume over the next **10**-**20** minutes, if necessary.
6. Reassess baseline data.
7. If HCT > 20% and TP not below 50% of starting value, and further fluid therapy is required, then give another one quarter of the calculated "shock" volume over **10** minutes.
8. Reassess baseline data.
9. If fluid therapy is still required, give the final one quarter of the calculated "shock" volume over **10**-**20** minutes.

- Give a hydroxyethyl starch (HES) IV or IO bolus of 10-20 mL/kg over 5-10 minutes if clinical signs of shock do not abate after the first 30 minutes (first 2 quarter-shock IV challenges) of crystalloid fluids, or response to crystalloid challenges is not sustained. Repeat this bolus if no response to therapy.

- Give a hypertonic saline (HTS) IV bolus of 4 mL/kg over 5 minutes (if 7-7.5% HTS is available) for MWDs that fail to respond to two or three quarter-shock boluses of crystalloids and/or one or two boluses of HES.

Clinical Pearls:

-Quick calculation for shock dose: Add a zero to the dog's weight in POUNDS for the quarter shock volume in mLs.

- CAUTION: Human blood products and albumin, or other animal blood products, must never be given to dogs, given the high risk of anaphylactic reactions.

- Blood product transfusions for MWDs are **ONLY** available from Veterinary Service Support units and their administration is only authorized under the direct supervision of a veterinarian.

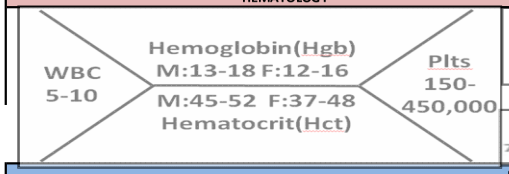
-Clinical target for resuscitation end point is a mean arterial pressure (MAP) of > 65 mmHg or a systolic of > 90 mmHg. Neonatal or pediatric blood pressure cuffs must be used.

-Consider TXA 10 mg/kg in 100 mL NS or LRS, IV over 15 min but NOT LATER THAN 3 HOURS post injury

DRUG	STANDARD DOSING	SMALL ADULT (60KG)132LBS	ADULT (80KG)176LBS	LARGE ADULT (100KG)220LBS	INDICATIONS	RESTRICTIONS/ WARNINGS	DURATION	REPEATABILITY/ MAX DOSE
ANTI-FIBRINOLYTIC								
Tranexamic Acid (TXA)	2000 mg IV/IO	**2 Grams in 100cc NS over 10min or slow IVP**			Int/Ext Hemorrhage	Give <3 hrs from injury/surgery	UNK	NO REPEAT
ANALGESIA								
Ketamine ** LOW-DOSE	0.1-0.2 mg/kg IV/IO >1 min	**6-12 mg**	**8-16 mg**	**10-20 mg**	Analgesia	HTN, Emergence	10-20 min	Q 10-20 min PRN for pain
Fentanyl (Sublimaze) **	0.5-1 mcg/kg IV/IO >3-5 min	**30-60mcg**	**40-80mcg**	**50-100mcg**	Analgesia, Sedation, AMI	Resp depression	20-30 min	Q 20-30 min PRN; MAX 4mcg/kg
Ketorolac (Toradol)	15mg IV or 15-30mg IM	**15mg IV or 15-30mg IM**			Musculoskeletal Pain	Not for Battlefield Trama	4-6hrs	15mg Q 6 hrs; MAX 120mg/day
Morphine **	2-5 mg IV/IO or 0.1 mg/kg IV	**6mg**	**8 mg**	**10mg**	Pain, Anxiolytic, AMI	Resp/BP drop; Head Tx	Variable	PRN for sedation if BP/Resp stable
SEDATION ** = Controlled Substance								
Ketamine ** HIGH DOSE	1-2 mg/kg IV/IO >2 min	**60-120mg**	**80-160mg**	**100-200mg**	Dissociative Sedation/ RSI	HTN, emergence, avoid sub- dissociative doses	10-20 min	1/2 to Full dose Q 10-20 PRN for sedation or 1-3 mg/kg/hr infusion
Propofol (Bolus)	1-2.5 mg/kg bolus IV/IO, q 5-10min PRN	**30-90mg**	**40-120mg**	**50-150mg**	RSI/General Anesthesia (Non-analgesic)	Hypotension (up to 30% of MAP)	3-10 min	Titrate to effect
Propofol (Constant Infusion)	10-75 mcg/kg/min IV/IO	**600-4500 mcg/min**	**800-6000 mcg/min**	**1000-7500 mcg/min**	General Anesthesia Maint. (Non-analgesic)	Hypotension (up to 30% of MAP)	Infusion	Titrate to effect
Etomidate	0.3mg/kg IV/IO push	**18mg**	**24mg**	**30mg**	Sedation, RSI (Non-analgesic)	Repeat doses can cause adrenal suppresion	5-10 min	NO REPEAT
Midazolam (Versed)**	0.05-0.1mg/kg IV/IO >1 min	**3-6mg**	**4-8mg**	**5-10mg**	Sedation, Seizures	BP/Resp drop	10-30 min	PRN q 15-30min if BP/Resp stable
PARALYTICS								
Rocuronium (Zemuron)	0.6-1.2 mg/kg IV/IO push	**60mg**	**80mg**	**100mg**	RSI/ Maint of paralysis	Must maintain PT airway	30-60min	PRN q 30-45min for paralysis
Succinylcholine	1-1.5 mg/kg IV/IO push	**75mg**	**100mg**	**125mg**	RSI	RSI Only	5-9 min	NO REPEAT
Vecuronium	0.1 mg/kg IV/IO push Reconstitute w/ 10 ml NS	**6mg**	**8mg**	**10mg**	Maint of paralysis	Must maintain PT airway	40-90 min	PRN q 40-90 min for paralysis
PRESSERS								
Epinephrine1mg/10mL	1mg/500ml NS= 2mcg/ml	**2-20mcg IVP q 2-5min or 2-20mcg/min IV/IO infusion**			Hypotension	Must be diluted/ Max resuscitation w/blood 1st	Infusion	Start low; Titrate to desired response
Norepinephrine (Levophed)	4mg/500 ml= 8 mcg/ml	**Start 2-20mcg/min infusion initally. (adjust for BP) Once BP is appropriate, 2-4mcg/min**			Hypotension	Max resus w/ blood 1st	Consistent Infusion	Start at lowest dose. Titrate up by 0.5mcg/min to MAP >60
Phenylephrine(NEO)	10mg/100ml NS= 100mcg/ml or 10mg/250ml NS= 40mcg/ml	**50-200mcg (1-5 ml) q 5-10 min IVP/IO**			Hypotension	Must be diluted/ Max resus w/ blood 1st	5-10 min	PRN to maintain SYS BP; start w/ low doses and titrate PRN
OD/Tox Ingestions (See also Sodium Bicarbonate, Calcium Chloride)								
Glucagon Kit	3-10mg IV/IO/IM	**3-10mg bolus; follow w/ 3-5mg/hr infusion**			Beta/Ca-ch blocker OD	Dosage is higher than kits	UNK	Titrate infusion for hemodynamics
Naloxone (Narcan)	0.4-2mg IV/IO/IM	**0.4-2mg titrated to appropriate ventilation**			Opioid OD	Use minimum needed	20-60 min	Q 2-3 min PRN (Max 10mg)
ANTI-EMETICS								
Zofran(Ondansetron)	4-8mg IV/IO/IM/PO	**4-8mg >30 sec**			Antiemetic	Can cause QT prolongation	4-6hrs	Max 8mg q 6 hrs
Promethazine (Phenergan)	12.5-25mg IV/IO/IM	**12.5-25mg**			Antiemetic/Sedation	Altered LOC/ Vesicant	4-6hrs	Max 25mg q 4 hrs
ANAPHYLAXIS								
Epinephrine 1mg/1mL	0.3-0.5mg IM; 0.1mg IV/IO	**1 Auto-Injector or 0.3mg IM; 0.1mg IV/IO**			Anaphylaxis	Hold for 10 sec	5-15m	Add doses Q 5-15 min until improve
Diphenhydramine (Benadryl)	25-50mg	**25-50mg PO; 50mg IV/IO**			Antihistamine	Minor sedation	4-8hrs	Max 50mg
Methylprednisolone/Solu-Medrol	125mg IV/IO	**125mg**			Anaphylaxis/Asthma	Do not use for head Tx	4hrs	NO REPEAT
RESPIRATORY (See also: Methylprednisolone)								
Albuterol(Nebulizer)	2.5-5mg	**2.5-5mg q 20 min prn (mixed in 3ml NS)**			Bronchodilator	Cardiac arrhythmia	1-4hrs	Max 3 initial doses; q 1-4hrs PRN
Albuterol(MDI)	4-8 Puffs	**4-8 Puffs Q 1-4 hrs**			Bronchodilator	Cardiac arrhythmia	1-4hrs	PRN q 1-4 hours
Epinephrine 1mg/1mL	0.3-0.5mg SQ/IM ***or*** 0.5ml Neb	**0.3-0.5mg SQ/IM q20min PRN *or* 0.5ml w/ 3ml NS**			Bronchodilator	No IV use	5-15m	Neb over 15 min/ Max 3x for SQ/IM
HYPOGLYCEMIA								
D50	10-25 Grams IV/IO	**20-50ml >5min**			Hypoglycemia	Intracranial hemorrhage	UNK	Titrate; avoid over-correction
Glucagon Kit	1mg	**1 Kit (1mg) IV/IM**			Hypoglycemia	Only if D50 not available	UNK	REPEAT every 20min
CARDIAC (See also Morphine or Fentanyl for AMI pain)								
Aspirin, Chewable, 81mg	324mg PO	**4 X 81mg Tablets (Chewed)**			Angina/ AMI	Must be chewed	4-6hrs	NO REPEAT
Nitroglycerin Tablet/Spray	0.4mg SL	**1 Tab/Spray SL Q 3-5 min---MAX 3**			Angina/ AMI	Maintain SYS BP>90	20-30 min	May repeat up to max of 3 Doses
Epinephrine 1mg/10mL	1mg	**1mg (1 amp) IV/IO Q 3-5 min for Arrest**			Pulseless Arrest	Profusing Tachycardia's	3-5 min	Repeat Q 3-5min w/ CPR-No Max
Amiodarone (Cardiac Arrest)	300mg 1st Dose/ 150 mg 2nd Dose (Follow w/20ml NS flush)	**300mg IV/IO bolus. If no change in 3-5min give 150 mg IV/IO.**			Refractory Pulseless V-Fib/V-Tach	Sinus Bradycardia, 2nd/3rd Deg Block	3-5 min	Max 2 doses
Amiodarone (Infusion)	150mg over 10-15min, followed by 1mg/min for 6hrs	**150mg infusion over 10-15min; followed by 360mg (1mg/min) infusion over 6hrs**			Hemodynamically unstable V-Tach/SVT	Sinus Bradycardia, 2nd/3rd Deg Block	Maintain drip	May repeat 150mg infusion q 10 PRN. Do not exceed 15mg/min
Adenosine	6mg/ 12mg IV/IO Rapid Push	**6mg 1st dose/12mg 2nd dose----Fast push w/ rapid, large (>20cc) flush**			Stable, narrow complex tach/PSVT	May cause transient Asystole following push	1-2 min	Give 2nd dose if no rhythm change in 1- 2 min
Atropine	1mg IV/IO	**1mg q 3-5 min**			Symptomatic Bradycardia	Glaucoma	5-15min	MAX 3mg (3 doses)
Epinephrine 1mg/10mL	0.05-0.5mcg/kg/min	**2-10mcg/minute infusion titrated to desired effect**			Symptomatic Bradycardia	Use if refractive to Atropine/Pacing	5-15min	MAX 3mg (6 doses)
Magnesium Sulfate	1-2 Gram IV/IO	**1-2 Gram diluted in 50ml D5W over 15 min(Torsades w/ pulse/VF/V-Tach)**			Torsades De Pointes (with or without pulse)	AV Blocks	30 min	Infusion of 1-2 Grams per hr needed following loading dose

DRUG	STANDARD DOSING	SMALL ADULT (60KG)132LBS	ADULT (80KG)176LBS	LARGE ADULT (100KG)220LBS	INDICATIONS	RESTRICTIONS/ WARNINGS	DURATION	MAX DOSE/ REPEATABILITY
CARDIAC-continued								
Sodium Bicarbonate	1mEq/kg IV/IO	**60mEq**	**80mEq**	**100mEq**	TCA OD; Prolonged Cardiac Arrest	Do not mix with other meds/ Flush line after	1-2hrs	Maint Infusion of 100-150mEq in 1L D5W @ 100-200ml/hr for TCA OD
Labetalol	10-20mg IV/IO over 1-2min	**10-20mg IV/IO over 1-2min**			HTN Urgency/Emergency	Lower MAP by <20%	15-60 min	Repeate one time
Calcium Chloride (100mg/ml)	Ca Gluconate can alternatively be used @ 3x doses listed here (except for Beta Blocker OD)	**500-1000mg over 2-5 min for Hyper K issues; 20mg/kg >5-10min for Beta Blocker OD; 1Gram >5min for Ca Ch Blocker OD; 1G>5min after Blood**			Hyperkalemia/ Beta&Calcium Channel Blocker OD	Central Line use preferred	30min-4 hrs	20mcg/kg/hr infusion for Beta OD; 1000mg Q 10-20 x 3 doses PRN for Ca Chan Blocker OD
CBRNE								
Atropine	0.05-0.1mg/kg IV/IO q 5-10 min PRN	**3mg**	**4mg**	**5mg**	Organophosphate/ Nerve Agent	Requires large amounts of Atropine (5-20 boxes)	5-15min	Double dose if previous dose does not relieve secretions(atropinization)
Pralidoxime Chloride (2-Pam) (DuoDote ATNAA)	1-3 Auto-Injectors (600mg ea)	**Inject 1-3 injectors (based on sverity of symptoms) IM. DuoDote/ATNAA Injector contains both Atropine (2.1mg) and 2-Pam(600mg)**			Organophosphate/ Nerve Agent	Use Atropine 1st if only using single dose 2-Pam (Mark 1/NAAK Kit)	15min	If symptoms remain after 15 min, re- inject subsequent doses (Max 1800mg 2 Pam)
Multi-Use/ Seizures/ Other								
Diazepam	Anxiety: 2-10mg IV/IM q 6hrs///Seizures: 5-10mg q 3-4hrs///Seizures following Nerve agent Exposure: 10mg IM for seizures or if 3x Mark 1 Kits used				Anxiety/ Seizures/ Nerve Agent Seizures	Respiratory Depression	20-30min	Max dose 30mg for seizures
Lorazepam	1-2mg IV/IO	**Seizures = 1-2mg q 10-15 prn; Agitated/Combative Patient = 1-2mg q 30-60**			Seizures/ Agitated or Combative Patient	Respiratory Depression	30-120min	Max 8mg in 12hrs for seizures
Magnesium Sulfate	1-2 Gram IV/IO	**Seizures = 1-2G over 30 min; Wheezing/ Respiratory Distress (3rd line) = 2G over 20 min; (Pre)Eclampsia = 4-6G over 15-20min**			Seizures/ Wheezing in Resp Distress/ (Pre)Eclampsia	Dilute into 50-100ml NS or D5W	30 min	2 Grams/hr infusion needed following loading dose for Eclampsia
Mannitol (20%)	1 Gram/kg IV over <20 min	**60G**	**80G**	**100G**	Mod to severe head Tx	Avoid in HoTN Pt's	3-8hrs	Follow with 0.25 Gram/kg IVP q 4hrs
FLUIDS								
Resuscitation (Crystaloid)	≤20ml/kg	**250-500 ml Bolus to achieve systolic BP >90**			Hypo-tension/volemia	Blood is 1st fluid choice	PRN	Titrate to maintain SBP >90
Maintenance	1-2 ml/kg	**75ml/hr(TKO)**	**105ml/hr(TKO)**	**150ml/hr(TKO)**	IV access/Homeostasis	Do not over hydrate	PRN	Titrate to effect
Burns >20% TBSA	LR 10ml * %TBSA (Based on 40- 80kg adult)	**10ml * % BSA Per Hour**	**10ml * % BSA Per Hour**	**10ml * % BSA+200ML Per Hour**	>20% TBSA partial or full-thickness burns	Track start time and amount infused	N/A	Add 100ml/hr for each 10kg over 80kg
Hypertonic Saline (3%)	0.1-1 ml/kg/hr	**250ml bolus followed by 50-100ml/hr**			ICP Reduction	Use only in Head Injuries	N/A	MAX 250ml
HetaStarch/Hextend (HTS)	250-500 ml	**250-500ml to achieve sys BP >90**			Int/Ext Hemorrhage	Equates to 1.5 L NS	2+ weeks	PRN up to 1500ml/day
Blood Products and Management	**(See also Epinephrine and Benadryl for Hemolytic Reactions)**							
PRBC (1u=250ml)	10ml/kg	**1-2 units PRN to achieve Sys BP ~90 (Shelf Life =42 days)**			Int/Ext Hemorrhage/ Uni Donor	O- Neg Monitor for Anaphylaxis/ Hyperthermia/HyperK	PRN	Repeat PRN to maintain SYS BP >90/ MAP >60/hemostasis
FFP (1u=200-250ml)	10ml/kg	**1-2 units PRN to achieve 1:1 ratio w/ PRBC's (Shelf Life(thawed) =5 days)**			Int/Ext Hemorrhage/ Uni Donor	AB+ Monitor for Anaphylaxis/ Hyperthermia	PRN	Ideal ratio of FFP:PRBC:Platelets is 1:1:1
Acetaminophen	500mg PO or 1G IV	**500mg PO or 1Gram IV infusion**			Febrile Reaction	Infuse slowly	6hrs	Use only for Non-Hemolytic react

HEMATOLOGY



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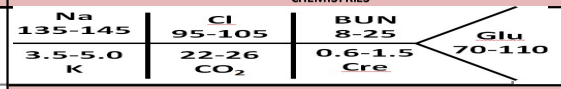
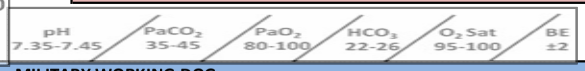


BLOOD GAS



VENTILATOR MANAGEMENT

Initial Vent Settings	
MODE	AC/ ASV (Hamilton T1 only)
RATE	14BPM
FiO2	1.0 (100%)
I:E	1:02
TIDAL VOLUME	6mL/kg (Ideal body weight)
PEEP	5 cm/H2O
Ideal Body Weight Calculation	
Men (kg)	50.0 + 2.3 x (Ht - 60 in)
Women (kg)	45.5 + 2.3 x (Ht - 60)

Troubleshooting

D.O.P.E.-- **D**isplacement; **O**bstructions; **P**neumothorax; **E**quipment Failure

MILITARY WORKING DOG

VITALS	Normal	Excited
Temperature	101-103 ºF	103 ºF
Respirations	16-30/MIN	Panting
Blood Pressure	120/80 (avg) mm Hg; MAP 90-100	
Heart Rate	60-80	
$EtCO_2$	35-45 mmHg	

FLUID MANAGEMENT

Shock: Calculate 90ml/kg for total fluid to be infused: Give 25% > 10 min; reasess; give 25% > 20 min(PRN); reassess; give 25% > 10 min(PRN); last 25% >10 min (PRN)

Intubate w/ 10.0 ET tube

Defib 2-5 Joules/Kg

INDICATION	K9 MEDICATIONS	NOTES
Anelgesia--Intermittent IV/IO/IM	**HYDROMORPHONE** 0.1-0.2mg/kg Q2-4hrs **OR MORPHINE** 0.2-0.5 mg/kg Q4-6hrs	
Analgesia-- Continuous IV/IO Infusion	**FENTANYL** 2-10 mcg/kg/hr **OR MORPHINE** 0.1-0.25 mg/kg/hr **OR HYDROMORPHONE** 0.02-0.05 mg/kg/hr	
Mild Sedation-- IM	**MIDAZOLAM** 0.3mg/kg IM **AND HYDROMORPHONE** 0.2mg/kg IM Q2-4hrs	
Agitated K9 Sedation-- IM 1st/IV PRN	**MIDAZOLAM** 0.3mg/kg **AND KETAMINE** 2mg/kg **AND HYDROMORPHONE** 0.2mg/kg	
Alternate K9 Sedation-- IV/IO	**PROPOFOL** 1 mg/kg boluses PRN to allow catheterization or intubation	
Cardiopulmonary Arrest BLS	Compressions @ 100/min; establish airway; Resperations @ 8-10/min for 2-3 minutes before ALS	
V-FIB/V-TACH	**Defib 2-5J/kg---2min CPR---Defib---EPI 0.01mg/kg AND Amiodarone 5-10mg/kg---2min CPR---Defib---2min CPR---Defib---EPI 0.01mg/kg AND Amiodarone 5-10mg/kg---2min CPR**	
ASYSTOLE/PEA/BRADYCARDIA	**ATROPINE** 0.04mg/kg IV/IO **AND EPINEPHRINE** 0.01 mg/kg	

ANTIBIOTIC THERAPY CHART

**Post-injury antimicrobial agents are recommended to prevent early post-traumatic infectious complications, including sepsis, secondary to common bacterial flora. Selection is based on narrowest spectrum and duration required to prevent early infections prior to adequate surgical wound management. This narrow spectrum is selected to avoid selection of resistant bacteria. The antimicrobials listed are not intended for use in established infections, where multidrug-resistant (MDR) or other nosocomial pathogens may be causing infection.*

Injury	Preferred Agent	Frequency	Duration
Extremity Wounds (Includes Skin, Soft Tissue, and Bone)			
Skin, soft tissue, **without** open fractures	Cefazolin 1-2g Or Ertapenem 1g	q 6-8hrs x 1 dose	24 hours
Skin, soft tissue, **with** open fractures, exposed bone, or open joints	Cefazolin 1-2g Or Ertapenem 1g	q 6-8hrs x 1 dose	24 hours, then with each subsequent I&D until soft tissue coverage
Thoracic Wounds			
Penetrating chest injury	Cefazolin 1-2g Or Ertapenem 1g	q 6-8hrs x 1 dose	24 hours
Penetrating chest injury **with** esophageal disruption	Cefazolin 1- 2g PLUS metronidazole 500 mg IV Or Ertapenem 1g	q 6-8hrs q 8-12hrs x 1 dose	Stop 24 hours after definitive closure
Abdominal Wounds			
Penetrating abdominal injury **with suspected/known** hollow viscus injury and soilage; may apply to rectal/perineal injuries as well	Cefazolin, 1-2g IV PLUS metronidazole 500 mg IV Or Ertapenem 1g	q 6-8hrs q 8-12hrs x 1 dose	Stop 24 hours after control of contamination
Maxillofacial And Neck Wound			
Open maxillofacial fractures, maxillofacial fractures **with** foreign body or fixation device	Cefazolin 1-2g g Or Ertapenem 1g	q 6-8hrs x 1 dose	24 hours
Central Nervous System Wounds			
Penetrating brain injury	Cefazolin 1-2g IV Or Ertapenem 1g	q 6-8hrs x 1 dose	5 days or until CSF leak is closed, whichever is longer
Penetrating brain injury **with** gross contamination with organic debris	Cefazolin 1-2g IV; *Consider* metronidazole 500 mg IV Or Ertapenem 1g	q 6-8hrs q 8-12hrs x 1 dose	5 days or until CSF leak is closed, whichever is longer
Penetrating spinal cord injury	Cefazolin 1-2g IV Or Ertapenem 1g	q 6-8hrs x 1 dose	5 days or until CSF leak is closed, whichever is longer
Penetrating spinal cord injury **with** abdominal cavity is involvement	Cefazolin, 1-2g IV PLUS metronidazole 500 mg IV Or Ertapenem 1g	q 6-8hrs q 8-12hrs x 1 dose	5 days or until CSF leak is closed, whichever is longer
Eye Wounds			
Eye injury, burn or abrasion	Erythromycin ophthalmic ointment Or Bacitracin ophthalmic ointment	q 6hrs or PRN for symptomatic relief	Until epithelium healed. No systemic treatment required
Eye injury, penetrating	Levofloxacin 750 mg IV/PO PLUS vancomycin 15-20 mg/kg IV Or Moxifloxacin 400 mg IV/PO once daily	q 24 hrs q 8-12hrs q 24hrs	7 days or until evaluated by an ophthalmologist. No topical agents.
Burns			
Superficial burns	Topical antimicrobials (mafenide acetate or silver sulfadiazine) OR silver impregnated dressing, PLUS excision and grafting	q 24hrs q 3-5d	Until healed
Deep partial thickness burns	Topical antimicrobials (mafenide acetate or silver sulfadiazine) OR silver impregnated dressing, PLUS excision and grafting	q 24hrs q 3-5d	Until healed or grafted
Full thickness burns	Topical antimicrobials PLUS excision and grafting	q 24hrs	Until healed or grafted
Delayed Evacuation to Surgical Care			
PO tolerable Not PO tolerable	Moxifloxacin 400 mg PO x 1 dose. Or Ertapenem 1 g IV/ IM	X 1 dose X 1 dose	Single dose therapy

mcg/ml
mg/ml

Fluid volume for Dilution

DRUG DOSE	5cc	10cc	20cc	50cc	100cc	250cc	500cc	1000cc
1mcg	0.20mcg/ml	0.1mcg/ml	0.05mcg/ml	0.02mcg/ml	0.01mcg/ml	0.004mcg/ml	0.002mcg/ml	0.001mcg/ml
5mcg	1mcg/ml	0.5mcg/ml	0.25mcg/ml	0.1mcg/ml	0.05mcg/ml	0.02mcg/ml	0.01mcg/ml	0.005mcg/ml
10mcg	2mcg/ml	1mcg/ml	0.5mcg/ml	0.2mcg/ml	0.1mcg/ml	0.04mcg/ml	0.02mcg/ml	0.01mcg/ml
25mcg	5mcg/ml	2.5mcg/ml	1.25mcg/ml	0.5mcg/ml	0.25mcg/ml	0.1mcg/ml	0.05mcg/ml	0.025mcg/ml
50mcg	10mcg/ml	5mcg/ml	2.5mcg/ml	1mcg/ml	0.5mcg/ml	0.2mcg/ml	0.1mcg/ml	0.05mcg/ml
100mcg	20mcg/ml	10mcg/ml	5mcg/ml	2mcg/ml	1mcg/ml	0.4mcg/ml	0.2mcg/ml	0.1mcg/ml
250mcg	50mcg/ml	25mcg/ml	12.5mcg/ml	5mcg/ml	2.5mcg/ml	1mcg/ml	0.5mcg/ml	0.25mcg/ml
500mcg	0.1mg/ml	50mcg/ml	25mcg/ml	10mcg/ml	5mcg/ml	2mcg/min	1mcg/ml	0.5mcg/ml
1mg	0.2mg/ml	0.1mg/ml	50mcg/ml	20mcg/ml	10mcg/ml	4mcg/ml	2mcg/ml	1mcg/ml
2mg	0.4mg/ml	0.2mg/ml	0.1mg/ml	40mcg/ml	20mcg/ml	8mcg/ml	4mcg/ml	2mcg/ml
3mg	0.6mg/ml	0.3mg/ml	0.15mg/ml	60mcg/ml	30mcg/ml	12mcg/ml	6mcg/ml	3mcg/ml
4mg	0.8mg/ml	0.4mg/ml	0.2mg/ml	80mcg/ml	40mcg/ml	16mcg/ml	8mcg/ml	4mcg/ml
5mg	1mg/ml	0.5mg/ml	0.25mg/ml	0.1mg/ml	50mcg/ml	20mcg/ml	10mcg/ml	5mcg/ml
6mg	1.2mg/ml	0.6mg/ml	0.3mg/ml	0.12mg/ml	60mcg/ml	24mcg/ml	12mcg/ml	6mcg/ml
7mg	1.4mg/ml	0.7mg/ml	0.35mg/ml	0.14mg/ml	70mcg/ml	28mcg/ml	14mcg/ml	7mcg/ml
8mg	1.6mg/ml	0.8mg/ml	0.4mg/ml	0.16mg/ml	80mcg/ml	32mcg/ml	16mcg/ml	8mcg/ml
9mg	1.8mg/ml	0.9mg/ml	0.45mg/ml	0.18mg/ml	90mcg/ml	36mcg/ml	18mcg/ml	9mcg/ml
10mg	2mg/ml	1mg/ml	0.5mg/ml	0.2mg/ml	0.1mg/ml	40mcg/ml	20mcg/ml	10mcg/ml
15mg	3mg/ml	1.5mg/ml	0.75mg/ml	0.3mg/ml	0.15mg/ml	60mcg/ml	30mcg/ml	15mcg/ml
25mg	5mg/ml	2.5mg/ml	1.25mg/ml	0.5mg/ml	0.25mg/ml	0.1mg/ml	50mcg/ml	25mcg/ml
50mg	10mg/ml	5mg/ml	2.5mg/ml	1mg/ml	0.5mg/ml	0.2mg/ml	0.1mg/ml	50mcg/ml
75mg	15mg/ml	7.5mg/ml	3.75mg/ml	1.5mg/ml	0.75mg/ml	0.3mg/ml	0.15mg/ml	75mcg/ml
100mg	20mg/ml	10mg/ml	5mg/ml	2mg/ml	1mg/ml	0.4mg/ml	0.2mg/ml	0.1mg/ml
250mg	50mg/ml	25mg/ml	12.5mg/ml	5mg/ml	2.5mg/ml	1mg/ml	0.5mg/ml	0.25mg/ml
500mg	100mg/ml	50mg/ml	25mg/ml	10mg/ml	5mg/ml	2mg/ml	1mg/ml	0.5mg/ml
750mg	150mg/ml	75mg/ml	37.5mg/ml	15mg/ml	7.5mg/ml	3mg/ml	1.5mg/ml	0.75mg/ml
1Gram	200mg/ml	100mg/ml	50mg/ml	20mg/ml	10mg/ml	4mg/ml	2mg/ml	1mg/ml

Value equals amount of fluid in each ml of dilution

Each ml of medication diluted into your chosen fluid still counts towards total solution volume (i.e. 1ml of drug + 4ml fluid = 5ml solution; 1ml drug + 9ml fluid = 10ml solution). Small volume medications (1-2ml) are inconsequential above dilutions >50ml

1mg=1000mcg	0.1mg=100mcg	0.01mg=10mcg

Y-Site Capatability Chart

	Amiodarone	Epinephrine	Etomidate	Fentanyl	Hydromorphone	Ketamine	Lorazepam	Midazolam	Morphine	Norepinephrine	Phenylephrine	Propofol	Rocuronium	Sodium bicarb	Succinylchloline	Vecuronium
Amiodarone		C			C	C	C	C	C		C			I	C	C
Epinephrine	C				C	C	C	C	C	C	C		C	I	C	C
Etomidate				C			C	C	C		C				C	I
Fentanyl		C	C		C	C	C	C	C	C	C	C	C	C	C	C
Hydromorphone	C	C		C		C	C	C	C	C	C	C	C	I	C	C
Ketamine	C	C		C	C			C	C			C		I		
Lorazepam	C	C	C	C	C			C	C	C	C	C	I	C	C	C
Midazolam	C	C	C	C	C	C			C	C	C	C-syringe	C	I	C	C
Morphine	C	C	C	C	C	C	C	C		C	C		C	C-Y; I-admixture	C	C
Norepinephrine		C		C	C		C	C	C		C	C		I	C	C
Phenylephrine	C	C	C	C	C		C	C	C	C			C	C	C	C
Propofol				C	C	C	C			C				C		C-admixture
Rocuronium	C	C		C	C		I	C	C					C		
Sodium bicarb	I	I		C	I	I	C	I	C	I	C	C	C		I	C
Succinylchloline	C	C	C	C	C		C	C	C	C	C			I		C
Vecuronium	C	C	I	C	C		C	C	C	C	C			C	C	
D50W																
Hetastarch	C-Y	C-Y		C-Y	C-Y		C-Y	C-Y	C-Y	C-Y	C-Y		C-Y	I-Y	C-Y	C-Y
LR		C-Y; solutn		C-Y	C-solutn			C-Y	C-Y, solutn	C-Y, solutn	C-Y, solutn	C-solutn	C-solutn	C-Y	C-Y, solutn	C-solutn
NS		C-solutn		C-solutn	C-solutn	C-solutn		C-solutn		C-solutn	C-solutn		C-solutn	C-solutn	C-solutn	C-solutn
NaCl 3%																
D5W	C-solutn	C-solutn		C-solutn	C-solutn	C-solutn		C-solutn	C-solutn	C-solutn	C-solutn		C-solutn	C-solutn	C-solutn	C-solutn
C=compatible																
I=Incompatible																
Y=Y-site																

Vasopressor Priority Chart

	HYPOVOLEMIC SHOCK	SEPTIC SHOCK	CARDIOGENIC SHOCK$_1$	NEUROGENIC SHOCK$_{2,3}$	BURN SHOCK$_4$
1°	**Vasopressors are not recommended in the initial stabilization of hypovolemic shock.**	Norepinephrine	Norepinephrine	Norepinephrine	Vasopressin
2°		Vasopressin	Dobutamine	Epinephrine	Norepinephrine
3°	Norepinephrine	Epinephrine	Epinephrine	Vasopressin	Epinephrine

- **Vasopressors should only be initiated with/after adequate resuscitation is provided with crystalloids, colloids, and/or blood products.**
- **Maintain mean arterial pressure (MAP) 65 mmHg or as needed to achieve adequate end-organ perfusion (e.g. cerebral perfusion pressure, abdominal perfusion pressure, urinary output).**

1. In low output Cardiogenic Shock, dobutamine may be initiated in combination with norepinephrine.
2. Due to the physiologic nature of Neurogenic Shock, vasopressors may be initiated earlier to avoid volume overload.
3. Phenylephrine should be avoided in most Neurogenic Shock patients due to unopposed alpha activity that can result in reflex bradycardia; further worsening spinal cord injury (SCI) associated bradycardia.
4. In Burn Shock casualties at risk of burn fluid over-resuscitation (e.g. 250mL/Kg in the 1st 24 hours), a continuous, non-titratable infusion of Vasopressin at 0.04 Units/minute (2.4 Units/hour) may be initiated to avoid volume overload.

MEDICATION, DRUG CARDS

a. General Use
    i. Use as clinically indicated per guideline.
b. Medications, all:
    ii. If carried, these medications are available for use, within the limitations of these guidelines, drug cards, and supervising medical director / physician. These medications may be used during transfer of critical care patients or during point of injury. These medications are available for use on any patient, within the limitations of these guidelines, as clinically indicated, to address acute life-threatening emergencies not accounted for on the transferring physician's written orders. Some medications utilized during critical care transfer requires written orders and guidance from transferring physician or as directed by unit medical director/supervising physician.

Oxygen

Class: Atmospheric gas.
Mechanism of Action: The essential substrate for cellular respiration.
Duration of action: Onset: immediate. Peak effect: not applicable. Duration: less than 2 minutes.
Indications: All causes of decreased tissue oxygenation and/or decreased level of consciousness. (Confirmed or expected hypoxemia, ischemic chest pain, respiratory, insufficiency, prophylactically during air transport, confirmed or suspected carbon monoxide poisoning). Also provides mechanical work for gas-powered ventilators, if supply and flow rate is sufficient (OBOGS will not work).
Contraindications: Coincidental paraquat inhalation (rare); COPD patients may become hypopneic with high O2 flow rates due to "oxygen baroreceptor respiratory drive (relative contraindication).
Adverse Reactions: Retinopathy of prematurity (prolonged use); potential oxygen toxicity in hyperbaric environments; cerebral vasoconstriction.
Drug Interactions: None
How Supplied: Medical grade Oxygen is 93% O_2 (+/- 3%) under United States Pharmacopeia (USP) Standards. USP Standard O_2 is supplied through compressed gas cylinders (D cylinder) or continuous flow oxygen generator or concentrator systems.
Dosage and Administration:
• Assure adequate ventilation (spontaneous or supported) coincidental to supplemental oxygen therapy, ideally by end-tidal CO_2 measurement (Goal EtCO2 35-45).
• All critically ill and injured transport patients will receive supplemental oxygen to maintain SPO_2 of > 93%.
• Administer oxygen 2-6 LPM via nasal cannula.
    ○ If O2 Saturation remains < 95%, apply non-rebreather face mask with oxygen at 15 LPM.
    ○ If O2 Saturation remains < 90%, refer to **Airway guideline**.
• Patient on Ventilator:
    ○ Adjust ventilator settings based on ventilatory goals for patient: ETCO2, peak pressures, SpO2, and patient clinical condition.
    ○ Adjust FiO2 to maintain pulse oxygen saturations > 93% / tissue oxygen saturation (STO_2) > 70%, if applicable.
• When planning for available O_2 during non-pressurized, aeromedical transfer, ensure adequate resources to provide 1.5 to 2 times the ground transport volume of O_2 to compensate for increased consumption associated with altitude related physiological impact.

0.9% Sodium Chloride (Normal Saline)

Class: Isotonic crystalloid solution.
Mechanism of Action: Replaces water and electrolytes.
Indications: Hypovolemia, Shock, Heat-related injuries, diabetic ketoacidosis, TKO IV, a diluent of choice for blood product transfusion.
Contraindications: Avoid for intravascular volume replacement for hemorrhagic shock due to hemodilution and hyperchloremic metabolic acidosis. Use with caution in patients with known congestive heart failure.
Adverse Reactions: Rare
Drug Interactions: Few in the pre-hospital emergency setting.
How Supplied: 250mL, 500mL, and 1,000mL bags.
Dosage and Administration: The specific situation being treated will dictate the rate in which normal saline will be administered. Hypovolemic shock requires rapid bolus (see relevant guidelines). In other cases, it is advisable to administer the fluid at a moderate rate (for example, 100 mL/h).

Hypertonic Saline 3% Sodium Chloride

Class: Hypertonic crystalloid solution.
Mechanism of Action: Replaces water and electrolytes, increases intravascular sodium concentration, may induce diuresis
Indications: Refractory elevated intracranial pressure (ICP) due to various etiologies (eg, subarachnoid hemorrhage, neoplasm); traumatic brain injury with elevated ICP: (Can be used in place of mannitol).
Contraindications: Do not use in the same line as Blood Products – cause crenation and lysis of RBC. Caution or avoid use in patients with known congestive heart failure and kidney disease.
Adverse Reactions: Rare
Drug Interactions: Few in the pre-hospital emergency setting.
How Supplied: 250mL, 500mL, bags.
Dosage and Administration:

- Dosing (Adult):
    - **Bolus**: 250mL IV Bolus over 15 min.
    - **Infusion**: 50-100 cc/hr
- Dosing (Pediatrics):
    - **Bolus**: 5 cc/kg IV Bolus over 15 min.
    - **Infusion**: 0.5 cc/kg/hr

Ringer's, Lactate (Lactated Ringers/Hartman's Solution)

Class: Isotonic crystalloid solution.
Mechanism of Action: Replaces water and electrolytes.
Indications: Hypovolemic shock; keep open IV.
Contraindications: Should not be used in the same line with blood components. Use with caution for intravascular volume replacement for hemorrhagic shock due to hemodilution and exacerbation of coagulopathy. Use with caution in patients with known congestive heart failure and kidney disease. Can cause lactic acidosis.
Adverse Reactions: Rare
Drug Interactions: Few in the pre-hospital emergency setting.
How Supplied: 250mL, 500mL, and 1,000mL bags. IV infusion.
Dosage and Administration: Hypovolemic shock; titrate according to the patient's physiologic response. (See appropriate Guidelines)

Dextrose 5% in Water (D5W)

Class: Hypotonic dextrose-containing solution.
Mechanism of Action: D5W provides nutrients in the form of dextrose as well as free water.
Indications: IV diluent for certain emergency drugs; for dilution of concentrated drugs for intravenous infusion.
Contraindications: Not for use as fluid replacement for hypovolemic states.
Adverse Reactions: Rare
Drug Interactions: Phenytoin (Dilantin)
How Supplied: Supplied in 50mL, 100mL, 150mL, 250mL, 500mL, and 1,000mL bags.
Dosage and Administration: Normally administered through a mini-drip (60 gtt/mL) set at a rate of "to keep open" (TKO).

PlasmaLyte A

Class: Isotonic crystalloid solution.
Mechanism of Action: Replaces water and electrolytes.
Indications: Hypovolemic shock; compatible with blood or blood components. It may be administered before or following the infusion of blood through the same administration set (i.e., as a priming solution), added to or infused concurrently with blood components, or used as a diluent in the transfusion of packed erythrocytes. PLASMALYTE A and 0.9% Sodium Chloride Injection are equally compatible with blood or blood components.
Contraindications: Use with caution for intravascular volume replacement for hemorrhagic shock due to hemodilution and exacerbation of coagulopathy. Use with caution in patients with known congestive heart failure and kidney disease. Excess administration may result in metabolic alkalosis.
Adverse Reactions: Rare
Drug Interactions: Few in the pre-hospital emergency setting.
How Supplied: 500mL, and 1,000mL bags IV infusion.
Dosage and Administration: Hypovolemic shock; titrate according to the patient's physiologic response. (See appropriate Guidelines)

ACETAMINOPHEN

♀C, **Lactation Yes** (Caution)

Trade Name: **Tylenol**

Class / Mechanism of Action

Analgesic

Blocks cyclooxygenase (COX 1 and 2) enzymes, resulting in reduced formation of prostaglandin precursors. Blocks formation of prostaglandin derivative, thromboxane A2, resulting in inhibited platelet aggregation. Has antipyretic, analgesic, and anti-inflammatory properties.

Indications

Labeled Indications: Treatment of mild to moderate pain and fever, Treatment of moderate to severe pain when provided via IV with opioid analgesia

Contraindications

- Hypersensitivity to acetaminophen or any component of the formulation
- Hepatic impairment or liver disease

Adverse Reactions / Precautions

- Use IV form cautiously in volume depleted patients
- Avoid use in patient suffering alcohol toxicity, known alcohol abuse, or renal impairment
- IV form can cause nausea and vomiting (especially in adults), headache

Dose and Administration:

ADULT

Pain or fever: (Limit total daily dose to <4 g/day

PO:

- Regular release: **325-650 mg** every 4-6 hours or **1000 mg** 3-4 times daily (maximum: 4 g daily)

RECTAL:

- **325-650 mg** every 4-6 hours or **1000 mg** 3-4 times daily (maximum: 4 g daily)

IV:

- <50 kg**: 15 mg/kg** every 6 hours
  - Max single dose: 15 mg/kg/dose (750 mg/dose)
  - Max daily dose: 75 mg/kg/day (≤3.75 g daily)
- ≥50 kg**: 1000** mg every 6 hours
  - Max single dose: 1000 mg/dose

PEDIATRIC Always Reference BROSELOW Tape

Pain or fever: Children ≥12 years & Adolescents: Refer to adult dosing

PO:

- Infants and Children <12 years**: 10-15 mg/kg/dose** every 4-6 hours as needed; do not exceed 5 doses (2.6 g) in 24 hours

RECTAL:

- Infants and Children <12 years**: 10-20 mg/kg/dose** every 4-6 hours as needed; do not exceed 5 doses (2.6 g) in 24 hours.

IV:

- Children 2-12 years: **15 mg/kg** every 6 hours or **12.5 mg/kg** every 4 hours
  - Max single dose: 15 mg/kg/dose (≤750 mg/dose)
  - Max daily dose: 75 mg/kg/day (≤3.75 g daily)

ACETAZOLAMIDE

♀C, **Lactation Yes**(Caution)

Trade Name: **Diamox**

Class / Mechanism of Action

Diuretic, Carbonic Anhydrase Inhibitor; Anticonvulsant

Inhibits carbonic anhydrase causing a decrease in hydrogen ion renal secretion with increased renal secretion of sodium, potassium, bicarbonate, and water. Onset of action PO: 2 hours, IV 5-10 minutes

Indications

Labeled Indications:

- Prevention or treatment of symptoms of acute mountain sickness
- Edema due to congestive heart failure

Contraindications

- Hypersensitivity to acetazolamide, sulfonamides, or any component of the formulation
- Confirmed low sodium / potassium levels otherwise none in emergency setting

Adverse Reactions / Precautions

- May worsen respiratory acidosis
- Drowsiness, deceased alertness, impairment of coordination, nausea, headache
- Flushing of skin, allergic skin reaction, skin photosensitivity

Dose and Administration:

ADULT

Altitude illness (Acute Mountain Sickness):

PO:

- **125-250 mg** twice daily.

Note: For high altitude cerebral edema (HACE), dexamethasone is the primary treatment; however, acetazolamide can be used (together with dexamethasone) at the AMS dose.

Edema (Only with referring doctor or medical director instruction):

PO, IV:

- **250-375 mg** once daily

PEDIATRIC Always Reference LB tape

Altitude illness (Acute Mountain Sickness):

PO: (IM not recommended due to alkaline pH)

- **2.5 mg/kg/dose** every 8-12 hours
  - MAX dose 250mg/dose.

Note: For high altitude cerebral edema (HACE), dexamethasone is the primary treatment; however, acetazolamide can be used (together with dexamethasone) at the AMS dose.

ACETYLSALICYLIC ACID

♀C, **Lactation Yes** (Short Term or Low Dose OK)

Trade Name: **Aspirin**

Class / Mechanism of Action

Nonsteroidal Anti-inflammatory Drug (NSAID)

Blocks cyclooxygenase (COX 1 and 2) enzymes, resulting in reduced formation of prostaglandin precursors. Blocks formation of prostaglandin derivative, thromboxane A2, resulting in inhibited platelet aggregation. Has antipyretic, analgesic, and anti-inflammatory properties.

Indications

Labeled Indications: Treatment of acute coronary syndromes (ST-elevation MI, non-ST-elevation MI, unstable angina), acute ischemic stroke, and transient ischemic episodes.

Contraindications

- Hypersensitivity to salicylates, other NSAIDs, or any component of the formulation
- Asthma, Rhinitis
- Inherited or acquired bleeding disorders (including factor VII and factor IX deficiency)
- Do not use in children less than 16 years old (Reye's syndrome)

Adverse Reactions / Precautions

- Not for use on trauma patients in the combat environment.
- Risk of bleeding: Avoid use in patients with known or suspected: Bleeding disorders, GI Bleed, GI Ulcers, patients taking Coumadin, or within 24hrs of taking Alteplase (tPA) for suspected stroke

Dose and Administration:

ADULT	PEDIATRIC Always Reference BROSELOW Tape
Acute coronary syndrome (ST-segment elevation myocardial infarction [STEMI], unstable angina (UA)/non-ST-segment elevation myocardial infarction [NSTEMI]): (Not for use in trauma patients): PO: • **324 mg** (chew nonenteric-coated aspirin as a single 325 mg tablet or 4 X 81 mg tablets)	**N/A:** **Contraindicated in children under 16 yrs (Reye's Syndrome)**

ACTIVATED CHARCOAL ♀Safe, Lactation Safe Trade Name: **Actidose**

Class / Mechanism of Action

Antidote

Non-absorbable agent that absorbs toxins within the GI tract inhibiting GI absorption.

Indications

Labeled Indications: Management of suspected or known poisonings when gastrointestinal decontamination is an option.

- Decontamination within 1 hour of ingestion of toxic substance

Contraindications

- Presence of intestinal obstruction or GI tract not anatomically intact
- Patients at risk of GI hemorrhage or perforation
- Patients with an unprotected airway (eg, CNS depression without intubation) or if use would increase the risk and severity of aspiration

Adverse Reactions / Precautions

- If patient unconscious, must establish airway control and must utilized NG/OG tube.
- Be prepared for possible emesis. Consider use of antiemetic.
- Avoid use in patients at risk of GI hemorrhage or perforation

Dose and Administration: ADULT	**PEDIATRIC** Always Reference BROSELOW Tape
Acute Poisoning: PO,NG/OG: • Single dose: **50 grams** • Multidose: After initial **50 gram** dose, follow with **25 grams** every 2 hours **Note:** Activated Charcoal has limited efficacy if not utilized within 1 hour of toxin ingestion. Risk-benefit of charcoal must seriously be considered because it does not work for all poisons, it must be given early when the poison is still in the stomach, it does not fully bind all poisons, and serious complications can occur with aspiration. Aspiration can occur if deteriorating mental status and/or vomiting. **Note:** Some products may contain sorbitol. Co-administration of a cathartic, including sorbitol, is no longer recommended. **Note:** Multidose charcoal is indicated if patient ingested a life-threatening amount of drug (carbamazepine, dapsone, phenobarbital, guanine, or theophylline)	**Acute Poisoning:** Children >12 years: Refer to adult dosing. PO,NG/OG: • Single dose: **1 gram/kg** • Multidose: Initial dose: **1Gram/kg** initially, followed by multiple doses of **0.5 Gram/kg** every 2 hours **Note:** Some products may contain sorbitol. Co-administration of a cathartic, including sorbitol, is no longer recommended. **Note:** Activated Charcoal has limited efficacy if not utilized within 1 hour of toxin ingestion.

ADENOSINE

♀C, Lactation Yes (Caution)

Trade Name: **Adenocard®**

Class / Mechanism of Action

Antiarrhythmic Agent

Slows conduction time through the AV node, inhibits re-entry pathways through the AV node, restoring normal sinus rhythm. The half-life of under 10 seconds allows for rapid repeat dosing.

Indications

Labeled Indications: Paroxysmal supraventricular tachycardia (PSVT) when clinically advisable, vagal maneuvers should be attempted first; not effective for conversion of atrial fibrillation, atrial flutter, or ventricular tachycardia.

Unlabeled: ALS/PALS Guidelines (2020): Stable, narrow-complex regular tachycardias; unstable narrow-complex regular tachycardias while preparations are made for synchronized direct-current cardioversion; stable regular monomorphic, wide-complex tachycardia as a therapeutic (if SVT) and diagnostic maneuver.

Contraindications

- Hypersensitivity to adenosine or any component of the formulation
- Second- or third-degree AV block, sick sinus syndrome, or symptomatic bradycardia (except in patients with a functioning artificial pacemaker)
- Use in patients with atrial fibrillation/flutter with underlying Wolff-Parkinson-White (WPW) syndrome (Fuster, 2006); asthma (ALS, 2020)
- Known or suspected bronchoconstrictive (Asthma) or bronchospastic lung disease.

Adverse Reactions / Precautions

- May cause transient asystole and new arrhythmia after cardioversion (PACs, AF, PVCs) chest discomfort
- Headache, Dizziness, Flushing, GI upset
- Dyspnea, Bronchospasm in asthmatics

Dose and Administration:

ADULT

Paroxysmal supraventricular tachycardia:

I.V. (rapid push, over 1-2 seconds, via proximal peripheral line (forearm or above, large bore).

- Initial: **6 mg;** if not effective within 1-2 minutes, **12 mg** may be given if needed (maximum single dose: 12 mg).

Notes): Follow each dose with **20 mL** normal saline flush.

Note: Initial dose of adenosine should be reduced to 3 mg if patient is currently receiving carbamazepine or dipyridamole, has a transplanted heart or if adenosine is administered via central line (ALS, 2020).

Note: Adenosine effects are antagonized by caffeine and theophylline, and patients may require higher doses.

PEDIATRIC Always Reference BROSELOW Tape

Paroxysmal supraventricular tachycardia:

IV/IO as close to core as possible (rapid push, over 1-2 seconds, see **Note**): Follow each dose with 10-20 mL normal saline flush..

- Initial: **0.1 mg/kg** (maximum initial dose: 6 mg); if not effective within 1-2 minutes, administer **0.2 mg/kg** (maximum single dose: 12 mg). Follow each dose with 5-10 mL normal saline flush.

ALBUTEROL

♀C, Lactation Yes

Trade Name: **Proventil / Ventolin**

Class / Mechanism of Action

Beta$_2$ Agonist (Bronchodilator)

Synthetic sympathomimetic that relaxes bronchial smooth muscle, causing bronchodilation, with little cardiac impact. Onset of action is 2-15 minutes

Indications

Labeled Indications: Treatment or prevention of bronchospasm in patients with reversible obstructive airway disease; prevention of exercise-induced bronchospasm

- Asthma
- Reactive Airway / Bronchospasm
- COPD
- May also be used in Crush Syndrome (Hyperkalemia)

Contraindications

- Hypersensitivity to albuterol or any component of the formulation
- Symptomatic tachycardia

Adverse Reactions / Precautions

- Risk of abortion during 1st or 2nd trimester
- Headache, Dizziness, Flushing, Diaphoresis, Tremor, Weakness
- Angina, A-Fib, Arrhythmia, Chest Pain, Palpitations
- Dyspnea, Bronchospasm in asthmatics

Dose and Administration:

ADULT

Bronchospasm:

Metered-dose inhaler (90 mcg/puff):

- **2 puffs** every 4-6 hours as needed

Solution for nebulization:

- **2.5 mg** 3-4 times daily as needed

Exacerbation of asthma (acute, severe):

Metered-dose inhaler:

- **4-8 puffs** every 20 minutes for up to 4 hours, then every 1-4 hours as needed

Solution for nebulization:

- **2.5-5 mg** every 20 minutes for 3 doses, then **2.5-10 mg** every 1-4 hours as needed.

PEDIATRIC Always Reference BROSELOW Tape

Bronchospasm:

Metered-dose inhaler (90 mcg/puff):

- **4-8 puffs** every 4-6 hours as needed

Solution for nebulization:

- Children ≤4 years: **2.5 mg** every 4-6 hours as needed
- Children ≥5 years: **2.5-5 mg** every 4-8 hours as needed
- Children ≥12 years: Refer to adult dosing.

Exacerbation of asthma (acute, severe):

Metered-dose inhaler (90 mcg/puff):

- Children <12 years: **4-8 puffs** every 20 minutes for 3 doses, then every 1-4 hours as needed
- Children ≥12 years: Refer to adult dosing.

Solution for nebulization:

- Children <12 years: **0.15 mg/kg** (minimum: 2.5 mg) every 20 minutes for 3 doses, then **0.15-0.3 mg/kg** (maximum: 10 mg) every 1-4 hours as needed
- Children ≥12 years: Refer to adult dosing.

AMIODARONE

♀**D, Lactation: Yes,** Not Recommended

Class / Mechanism of Action

Antiarrhythmic Agent, Class III

Inhibits adrenergic stimulation (alpha and beta blocking), prolongs action potential and refractory period (prolongs PR and QT intervals); decreases AV conduction and sinus node function (decreases sinus rate)

Indications

Labeled Indications: Management of life-threatening recurrent ventricular fibrillation (VF) or hemodynamically unstable ventricular tachycardia (VT) refractory to other antiarrhythmic agents

Unlabeled:

- Recurrent, hemodynamically unstable VT. (after other drugs have failed)
- Ventricular tachyarrhythmias (ACLS/PALS 2015): VF/VT Cardiac arrest unresponsive to CPR, Shock, and Vasopressor.

Contraindications

- Hypersensitivity to amiodarone, iodine, or any component of the formulation
- Severe sinus-node dysfunction
- 2nd and 3rd degree heart block (except in patients with a functioning artificial pacemaker)
- Bradycardia causing syncope (except in patients with a functioning artificial pacemaker)
- Cardiogenic shock

Adverse Reactions / Precautions

- **Complex drug with multiple complex drug reactions! (Do not administer with procainamide)**
- Hypotension
- Dizziness, fatigue, Headache, Poor coordination, Neuropathy
- Nausea, Vomiting
- Dysrhythmias, Asystole, AF, Bradycardia, AV block, Conduction abnormalities, SA node dysfunction

Dose and Administration:

ADULT

Pulseless VT or VF (ACLS, 2015):

IV/IO push

- **300 mg** rapid bolus; should be diluted in 30 mL of NS, Plasmalyte, or D5W; if pulseless VT or VF continues after subsequent defibrillation attempt or recurs, administer **supplemental dose of 150 mg.**

Recurrent, Hemodynamically unstable VT (ACLS, 2015):

Initial Dose:

IV/IO slow push

- **150mg IV** over 1st 10 minutes (15mg per minute) dilute in 100 ml of NS, PlasmaLyte, or D5W (concentration 1.5mg/ml).
- May repeat **150 mg** every 10 minutes PRN if VT recurs

Maintenance Infusion following initial dosing:

- **360 mg** over 6 hours (1 mg/ min) dilute in 500ml of NS, PlasmaLyte, or D5W (concentration 0.72 mg/ml).

PEDIATRIC Always Reference BROSELOW Tape

Pulseless VT or VF (PALS, 2015):

IV/IO push

- **5mg/kg** IV bolus during cardiac arrest, May repeat twice for refractory VF/pulseless VT.
- Max single dose: 300mg

Tachycardia with Pulse and poor perfusion, or symptomatic with adequate perfusion (PALS, 2015):

IV/IO push

- Loading dose: **5mg/kg** over 20 to 60 minutes (Fast push or bolus can precipitate cardiac failure!)
- Can repeat two times (max dose: 15 mg/kg in 24 hrs)
- Max single dose: 300mg

AMIODARONE					
Initial Dose: 15mg/min over 10 min (150mg over 10min)					
MIX 150 mg/100 mL CONCENTRATION 1.5 mg/mL					
Dose	Rate	Micro (60	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mg/min	mL/min	gtt/min	gtt/min	gtt/min	gtt/min
15	10	600	200	150	100
Macro-Drip (10gtt/ml) is set of choice for this infusion					
Set rate provides complete initial infusion of 150mg over 10 minutes. May repeat Q 10 min PRN if VT recurs					

Maint Dose: 1mg/min over 6 hrs (360mg over 360min)					
MIX 360 mg/500 mL CONCENTRATION 0.72 mg/mL					
Dose	Rate	Micro (60	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mg/min	mL/min	gtt/min	gtt/min	gtt/min	gtt/min
1	1.4	84	28	21	14
Macro-Drip (20gtt/ml) is set of choice for this infusion					
Set rate provides maintenance infusion of 360mg over 6hrs.					

ATROPINE Sulfate

♀C, **Lactation: Yes,** Use Caution

Trade Name: **AtroPen**

Class / Mechanism of Action

Anticholinergic, Antidysrhythmic, Antidote for Carbamate Anticholinesterase poisoning

Blocks acetylcholine at parasympathetic sites in smooth muscle, secretory glands, and the CNS; increases cardiac output, and dries secretions. Atropine reverses the muscarinic effects of cholinergic poisoning. Reverses bronchorrhea and bronchoconstriction, but does not affect the nicotinic receptors responsible for muscle weakness, fasciculations, and paralysis.

Indications

Labeled Indications: Treatment of

- Symptomatic Sinus Bradycardia, AV block (nodal level)
- Antidote for anticholinesterase poisoning (carbamate insecticides, nerve agents, organophosphate insecticides)

Contraindications

- Hypersensitivity to atropine or any component of the formulation
- Narrow-angle glaucoma; adhesions between the iris and lens (ophthalmic product)
- Pyloric stenosis
- Prostatic hypertrophy
- **Note:** NO contraindications should prevent use of atropine in setting of life threatening organophosphate, carbamate, or nerve agent poisoning

Adverse Reactions / Precautions

- Tachycardia and arrhythmia (VTach, VFib), Hypotension, Palpitations
- Dilated Pupils, Angle-closure glaucoma
- Headache, Dry Mouth, constipation, urinary retention, flushing
- **Paradoxical Bradycardia noted with doses less than 0.1mg**

Dose and Administration: **ADULT** | **PEDIATRIC** Always Reference BROSELOW Tape

Symptomatic Bradycardia

IV/IO

- **1 mg** every 3-5 minutes, not to exceed a total of 3 mg or 0.04 mg/kg (ARC, 2020)

Organophosphate or carbamate insecticide or nerve agent poisoning:

IV/IM: (Used with 2-Pam Chloride auto injector)

- *Initial:* 1-6 mg; repeat every 3-5 minutes as needed, doubling the dose if previous dose did not induce atropinization. Maintain with repeat doses as needed for ≥ 2-12 hours based on recurrence of symptoms.

IM *(**AtroPen®**):* anterolateral aspect of thigh and hold in place for 10 seconds. Follow with 2-Pam Chloride auto injector.

- Mild symptoms (≥2 mild symptoms): **2 mg** once an exposure is known or strongly suspected.
- Severe symptoms (≥1 severe symptom): **Three** 2 mg doses in rapid succession.

Mild and Severe Symptoms are noted on product labeling and **Pralidoxime Chloride** drug card.

Symptomatic Bradycardia

IV/IO

- **0.02 mg/kg** (Minimum dose is 0.1 mg. Maximum single dose of 0.5 mg. May repeat once in 3-5 minutes. Maximum total dose is 1 mg (PALS, 2020)

Organophosphate or carbamate insecticide:

- IV/IO: Initial: **0.05-0.1 mg/kg**; repeat every 5-10 minutes as needed, double dose if previous dose does not induce atropinization. Maintain with repeat doses as needed for ≥2-12 hours based on recurrence of symptoms.

Severe Nerve Agent Poisoning:

- IV/IO 1mg every 3 min. Monitor Patient for signs and symptoms of atropinization, (drying up of secretions). Once clinical improvement is achieved restrict to 10-20% of original dose (approximately 2-4mg/hr)

CALCIUM Chloride 10% ♀Safe, Lactation Safe

Class / Mechanism of Action

Calcium Salt, Electrolyte Supplement
Moderates nerve and muscle contractility via action potential excitation threshold regulation

Indications

Labeled Indications: Treatment of hypocalcemia and conditions secondary to hypocalcemia (eg, tetany, seizures, arrhythmias); emergent treatment of severe hypermagnesemia; massive transfusion prophylaxis
Unlabeled: Calcium channel blocker overdose; beta-blocker overdose (refractory to glucagon and high-dose vasopressors); severe hyperkalemia (K+ >6.5 mEq/L with toxic ECG changes) [ALS guidelines]; malignant arrhythmias (including cardiac arrest) associated with hypermagnesemia [ALS guidelines]

Contraindications

- Known or suspected digoxin toxicity
- Not recommended as routine treatment in cardiac arrest (includes asystole, ventricular fibrillation, pulseless ventricular tachycardia, or pulseless electrical activity)
- Hypercalcemia

Adverse Reactions / Precautions

- Hypokalemia: Use with caution in patients with severe hypokalemia. Acute rises in calcium can cause life-threatening arrhythmias
- Rapid push can cause: Arrhythmia, bradycardia, cardiac arrest, hypotension, syncope, vasodilation
- **Use small IV / Large Vein, flush prior and after, AVOID Extravasation** (will cause tissue necrosis)
  - In general, IV Calcium Gluconate is preferred over IV Calcium Chloride in nonemergency settings due to the potential for extravasation with calcium chloride
- **Do not infuse calcium chloride in the same I.V. line as phosphate-containing solutions.**
- Precipitates with $NaHCO_3$ in IV Bag/Tubing

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

ADULT

Cardiac arrest or cardiotoxicity in the presence of hyperkalemia, hypocalcemia, or hypermagnesemia: IV/IO, **SLOW**

- **500-1000 mg** over 2-5 minutes

Beta-blocker overdose, refractory to glucagon and high-dose vasopressors (unlabeled use): IV/IO

- **20 mg/kg** over 5-10 minutes followed by an infusion of 20 mg/kg/hour titrated to adequate hemodynamic response

Calcium channel blocker overdose (unlabeled use) (CaCl preferred over Calcium Gluconate for this use**):** IV/IO

- Initial: **1000mg** over 5 minutes; may repeat every 10-20 minutes with 3-4 additional doses; or a continuous infusion of 2-6 grams/hour may be initiated

Hypocalcemia prophylaxis from massive transfusion

- **10ml (10cc) 10% solution** over 5 minutes

Damage Control Resusitation: IV/IO, **SLOW**
1000 mg after 1st blood unit and after every 4th unit

PEDIATRIC

Cardiac arrest or cardiotoxicity in the presence of hyperkalemia, hypocalcemia, or hypermagnesemia:
IV/IO, **SLOW**

- **20 mg/kg** (maximum: 2000 mg/dose); may repeat as necessary

Calcium channel blocker overdose (unlabeled use):
IV/IO

- Initial: **20 mg/kg** (0.2ml/kg) (maximum: 1000 mg/dose) over 10-15 minutes; may repeat every 10-15 minutes

Note: Adult and Pediatric dosages are expressed in terms of the calcium chloride salt based on a solution concentration of 100 mg/mL (10%) containing 1.4 mEq (27 mg)/mL elemental calcium. (1gram = 10cc of a 10% solution)

Note: Calcium Chloride is 3X more potent than Calcium Gluconate and therefore lower doses of Calcium Chloride must be used to reach similar therapeutic doses

CALCIUM Gluconate ♀Safe, Lactation Safe

Class / Mechanism of Action

Calcium Salt, Electrolyte Supplement
Moderates nerve and muscle contractility via regulation of action potential excitation threshold.

Indications

Labeled Indications: Treatment of hypocalcemia and conditions secondary to hypocalcemia (e.g, tetany, seizures, arrhythmias); cardiac disturbances secondary to hyperkalemia; magnesium sulfate overdose; massive transfusion prophylaxis
Unlabeled: Calcium channel blocker overdose; treatment of hydrofluoric acid exposure

Contraindications

- Ventricular fibrillation
- Hypercalcemia
- Concomitant use of IV calcium gluconate and ceftriaxone in neonates (risk of precipitation of calcium-ceftriaxone)

Adverse Reactions / Precautions

- Hypokalemia: Use with caution in patients with severe hypokalemia. Acute rises in calcium can cause life-threatening arrhythmias
- Rapid push can cause: Arrhythmia, bradycardia, cardiac arrest, hypotension, syncope, vasodilation
  - Do not exceed 200mg/min except in emergency situations
- Caution in patients receiving digoxin therapy, may cause arrhythmias
- **Use small IV / Large Vein, flush prior and after, AVOID extravasation** (will cause tissue necrosis)
  - In general, IV Calcium Gluconate is preferred over I.V. calcium chloride in nonemergency settings due to the potential for extravasation with calcium chloride
- **Do not infuse calcium chloride in the same I.V. line as phosphate-containing solutions.**
- Precipitates with $NaHCO_3$ in IV Bag/Tubing

Dose and Administration: ADULT

Cardiac arrest or cardiotoxicity in the presence of hyperkalemia, hypocalcemia, or hypermagnesemia:
IV/IO, **SLOW**

- **1500-3000mg** over 2-5 minutes

Calcium channel blocker overdose (off-label use):
Hypotension/conduction disturbances:
IV/IO

- **3 Grams** (3000mg) over 5 minutes; may repeat every 10-20 minutes with 3-4 additional doses.

Hypocalcemia prophylaxis from massive transfusion

- **30mL of 10% solution** over 5 minutes
  Note: Calcium Chloride is 3X more potent than Calcium Gluconate and therefore higher doses of Calcium Gluconate must be used to reach similar therapeutic doses.

Hydrofluoric Acid Exposure – (off-label, see Burn SMOG)

- Topical therapy: After **thorough irrigation**, a CaGlu gel (75mL KY Jelly + 25mL 10% CaGlu) can be made and applied to the affected area, left on for 30 minutes, cleaned off, and repeated every 4 hours. Assess for pain relief and monitor EKG. (NO Calcium Chloride!)

Dose and Administration: PEDIATRIC Always Reference BROSELOW Tape

Cardiac arrest or cardiotoxicity in the presence of hyperkalemia, hypocalcemia, or hypermagnesemia:
IV/IO, **SLOW**

- **60-100 mg/kg/dose** (maximum: 3000 mg/dose)

Calcium channel blocker overdose (unlabeled use): *Hypotension/conduction disturbances:*
IV/IO

- **45 mg/kg** (maximum 3000mg/dose) over 10-15 minutes; may repeat every 10-15 minutes

Hypocalcemia prophylaxis from massive transfusion

- **60mg/kg (maximum 30ml of 10% solution) over 5 minutes**

Note: Calcium chloride may provide a more rapid increase of ionized calcium in critically ill children.

CEFAZOLIN

♀C, Lactation Yes

Trade Name: **Ancef**

Class / Mechanism of Action

Antibiotic (Cephalosporin 1st Gen)

Bacteriocidal - Inhibits bacterial cell wall synthesis by binding to one or more of penicillin-binding proteins which inhibits cell wall biosynthesis, causing bacteria to eventually lyse.

Indications

Labeled Indications: Used for infection control prophylaxis for traumatic open injuries and surgical prophylaxis.

Contraindications

- Hypersensitivity to cefazolin, other cephalosporin antibiotics, other beta-lactams, or any component of the formulation
- Some cross reactions occur in those with penicillin allergies. Use with caution.

Adverse Reactions / Precautions

- Superinfection – prolonged use may result in fungal or bacterial superinfection (including C.Difficile)
- Increased INR (bleeding risk) – especially in nutritionally-deficient, hepatic/renal disease, prolonged treatment

Dose and Administration:

ADULT

Infection Control:

Routine dosing may be based on body mass:

1g if weight <80kg

2g if weight 81-160 kg (177-352 lbs),

3g if weight > 160 kg (>352 lbs)

Max dose is 12g per day

War wounds (dirty wounds), 2g in 250 mL NS IV over 5 min every 8 hours for 24 hours is adequate for most dirty wounds of the head and neck, torso, and extremities.

IV:

Adults:

- 1-2g every 6-8hrs
  - Max daily dose: 12 g/day

PEDIATRIC

Infection Control:

IV:

Pediatrics:

- 20-30 mg/kg IV q6-8h (maximum, 100 mg/kg/day)
  - Max daily dose: 100 mg/kg/day

DEXAMETHASONE ♀C, Lactation ?(Not Recommended) Trade Name: **Decadron**

Class / Mechanism of Action

Systemic Corticosteroid
Anti-inflammatory, Immunosuppressant Onset of action, IV: Prompt; Duration IV: 72 hours

Indications

Labeled Indications:

- Anti-inflammatory or immunosuppressant in treatment of a variety of diseases: allergic, dermatologic, endocrine, hematologic, inflammatory, neoplastic, renal, respiratory, rheumatic, and autoimmune
- Management if cerebral edema

Unlabeled:

- Treatment of acute mountain sickness (AMS) and high altitude cerebral edema.

Contraindications

- Hypersensitivity to dexamethasone or any component of the formulation
- Systemic fungal infection, cerebral malaria

Adverse Reactions / Precautions

- Not for use in treatment of head injury; increased mortality has occurred in head injury patients treated with high dose IV methylprednisolone. Corticosteroids should not be used in head injuries.

Dose and Administration: **ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
Acute mountain sickness (AMS)/high altitude cerebral edema (HACE) (unlabeled use): PO, IM, IV: • AMS: **4 mg** every 6 hours • HACE: **8 mg** as a single dose; followed with: 4 mg every 6 hours until symptoms resolve	**Acute mountain sickness (AMS)/high altitude cerebral edema (HACE)** (unlabeled use): PO, IM, IV: • **0.15 mg/kg/dose** every 6 hours ○ consider use in high altitude pulmonary edema because of associated HACE with pulmonary edema

DEXTROSE 50% ♀C, Lactation? Trade Name: **Glutose / B-D Glucose**

Class / Mechanism of Action

Antidote, Hypoglycemia

Basic source of calories (fuel) for the body and brain, regulated by insulin. Rapidly increases blood glucose, decreases protein and nitrogen loss, preventing ketosis, and promotes glycogen deposition in liver.

Onset of action: Treatment of hypoglycemia Oral dose: 10 minutes

Maximum effect: Treatment of Hyperkalemia IV: 30 minutes

Indications

Labeled Indications: Treatment of:

- Hypoglycemia: Doses may be repeated in severe cases
- Hyperkalemia: (Must be used in combination WITH Insulin)

Contraindications

- Known Hyperglycemia, otherwise None in the Pre-hospital setting

Adverse Reactions / Precautions

Most adverse effects associated with excessive dose or infusion rate

- If evidence of malnutrition or alcohol abuse, thiamine should be given 1st
- **Tissue Necrosis if Extravasation occurs**; immediately D/C and change IV site
- Hyperglycemia
- Hypokalemia
- Hyponatremia

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Hypoglycemia:

Oral:

- **4-20 g** as a single dose; may repeat if necessary

IV:

- **10-25 g** (40-100 mL of 25% solution or 20-50 mL of 50% solution)

Note: Society of Critical Care Medicine recommends: Treat blood glucose <70 mg/dL (<100 mg/dL in patients with neurologic injury) immediately by stopping insulin therapy (if receiving) and administering 10-20 g (20-40 mL of 50% solution) IV; repeat blood glucose measurement in 15 minutes with repeat dextrose as needed; **avoiding overcorrection**.

Hypoglycemia:

Oral:

- **4-20 g** as a single dose; may repeat if necessary

IV:

- Newborns: **5ml/kg D10** (Max 25 G/dose)
- Infants and Children: **2ml/kg D25** (Max 25 G/dose)
- Adolescents: Refer to adult dosing

Note:

- **D25**= 25ml NS + 25ml D50 (12.5g in 50ml's solution)
- **D10**= 100ml NS + 25ml D50 (12.5g in 125ml's solution)
  or
  40ml NS + 10ml D50 (5g in 50ml's solution)

DIAZEPAM

♀**D, Lactation Yes** (Unsafe) Trade Name: **Valium**

Class / Mechanism of Action

Benzodiazepine;
Acts as an Anxiolytic/Hypnotic, anticonvulsant and sedative – Long Half Life (25-100hrs)
Onset of action: IV, Almost Immediate
Duration: IV, 20-30 minutes

Indications

Labeled Indications:

- Anxiety Disorders
- Convulsive Disorders and Alcohol Withdrawal Symptoms
- Skeletal Muscle Relaxant
- Induce Sedation and Amnesia (Midazolam is primary medication)

Contraindications

- Hypersensitivity to diazepam or any component of the formulation or other benzodiazepines
- Acute narrow angle glaucoma , Acute Alcohol Intoxication
- Respiratory Insufficiency/Depression **(Overdose Reversal: FLUMAZENIL** can be used, however it carries elevated risk. Respiratory support until the medication is metabolized is traditionally the best care in Benzodiazepine overdose**)**
- Neurologic Depression (Head Trauma)

Adverse Reactions / Precautions

- **No Analgesic properties** (Narcotic pain control is needed for RSI'd / Intubated trauma patients)
- May Cause Respiratory depression: Do not give without stable IV line and BVM (airway control) ready
- Hypotension, vasodilation
- Amnesia, confusion, drowsiness, slurred speech (Paradoxical Reactions possible: aggressiveness, agitation, anxiety, inappropriate behavior)

Dose and Administration:

ADULT

Anxiety:
Oral, IV, IM: (Oral and IV doses more reliable)

- **2-10 mg** 2-4 times/day if needed

Status Epilepticus:
IV: (SLOW)

- **5-10 mg** every 5-10 minutes given over 3 minutes (maximum dose: 30 mg)

Sedation in ICU patient:
IV:

- Loading dose: 5-**10 mg;** Maintenance dose: **0.03-0.1 mg/kg** every 30 minutes to 6 hours

Muscle Spasm:
IV:

- Initial: **5-10 mg**; then 5-10 mg in 3-4 hours, if necessary. Larger doses may be required if associated with tetanus.

Nerve Agent Exposure (CBRNE)
IM:

- **10mg** for seizures associated with Nerve Agent exposure; or if 3 MARK 1 kits were used on a casualty

PEDIATRIC Always Reference BROSELOW Tape

Sedation / Muscle relaxation / Anxiety :
IV, IM (IV doses more reliable)

- Children: **0.04-0.3 mg/kg/dose** every 2-4 hours to a maximum of 0.6 mg/kg within an 8-hour period if needed

Status Epilepticus:
IV:

- Infants >30 days and Children <5 years: **0.2-0.5 mg** given slowly every 2-5 minutes (maximum total dose: 5 mg); repeat in 2-4 hours if needed
- Children ≥5 years: **1 mg** given slowly every 2-5 minutes (maximum total dose: 10 mg); repeat in 2-4 hours if needed

Muscle spasm associated with tetanus:
IV, IM

- Infants >30 days and Children <5 years: **1-2 mg/dose** every 3-4 hours as needed
- Children ≥5 years: **5-10 mg/dose** every 3-4 hours as needed

DILTIAZEM

♀C, **Lactation?**(Not Recommended) Trade Name: **Cardizem**

Class / Mechanism of Action

Calcium Channel Blocker; Antiarrhythmic Agent, Class IV

Inhibits calcium ion from entering the "slow channels" or select voltage-sensitive areas of vascular smooth muscle and myocardium during depolarization; produces relaxation of coronary vascular smooth muscle and coronary vasodilation; increases myocardial oxygen delivery in patients with vasospastic angina. Onset of action: IV: 3 minutes, Duration 1-3 hours

Indications

Labeled Indications: Atrial fibrillation or atrial flutter for acute ventricular rate control, conversion of supraventricular tachycardia, hypertension, chronic stable angina, vasospastic angina.

Unlabeled: Hypertrophic cardiomyopathy; Idiopathic ventricular tachycardia; Nonsustained ventricular tachycardia or ventricular premature beats, symptomatic; Pulmonary arterial hypertension (group 1).

Contraindications

- Sick sinus syndrome (except in patients with a functioning artificial pacemaker); Second- or third-degree AV block
- Atrial fibrillation or flutter associated with accessory bypass tract (WPW, short PR syndrome)
- Severe hypotension; Cardiogenic shock; Hypersensitivity to diltiazem or any formulation component
- Ventricular tachycardia (with wide-complex tachycardia [QRS ≥0.12 seconds], must determine whether origin is supraventricular or ventricular)

Adverse Reactions / Precautions

- Cardiovascular: Edema, atrioventricular block, bradycardia, hypotension, dyspnea
- Central nervous system: Headache, dizziness, pain, nervousness, vomiting, weakness, myalgia

Dose and Administration: ADULT

Atrial fibrillation or atrial flutter, rate control:

Note: For rate control in hemodynamically stable patients. Do **not** use in patients with preexcitation associated with an accessory pathway, as this can lead to ventricular arrhythmias.

IV:

- Bolus dose: 0.25 mg/kg (actual body weight) over 2 minutes (average dose: 20 mg); if rate control is insufficient after 15 minutes, a repeat bolus dose of 0.35 mg/kg over 2 minutes may be given (average dose: 25 mg). Patients who respond after 1 or 2 bolus doses can be started on a continuous infusion.
- Continuous infusion following bolus(es): Initial: 5 to 10 mg/hour; infusion rate may be increased in 5 mg/hour increments according to ventricular response, up to a maximum of 15 mg/hour.

Supraventricular tachycardia (alternative agent):

Note: For hemodynamically stable patients if vagal maneuvers and/or adenosine are unsuccessful.

- Bolus dose: 0.25 mg/kg (actual body weight) over 2 minutes (average dose: 20 mg); if rate control is insufficient after 15 minutes, a repeat bolus dose of 0.35 mg/kg over 2 minutes may be given (average dose: 25 mg). If bolus(es) do not terminate the arrhythmia, consider alternative therapy.

PEDIATRIC Always Reference BROSELOW Tape

Atrial tachyarrhythmias, rate control:

Very limited data available: Infants, Children, and Adolescents

IV:

- Initial bolus: 0.25 mg/kg over 5 minutes (maximum dose: 20 mg/dose [average adult dose]) followed by a continuous IV infusion. Dose should be individualized based on patient response.
- Continuous infusion (titrated to effect): 0.05 to 0.15 mg/kg/hour (Rate control achieved ≈10min)

DIPHENHYDRAMINE ♀B, Lactation Yes (Unsafe) Trade Name: **Benadryl**

Class / Mechanism of Action

Histamine H_1 Antagonist;
Competes with histamine for H1-receptor sites within the gastrointestinal tract, blood vessels, and respiratory tract; Also produces anticholinergic and sedative effects

Indications

Labeled Indications:
- Anaphylaxis and allergy disorders
- Motion Sickness
- Antitussive

Contraindications
- Hypersensitivity to diphenhydramine or any component of the formulation
- Acute Asthma
- Use on Neonates, premature infants, Nursing mothers

Adverse Reactions / Precautions
- Normally causes sedation, but may cause paradoxical excitation in children
- May have increased sedative effects when used with other sedatives or alcohol
- May cause hypotension (use with caution in patient with cardiovascular disease)
- Dry mouth

Dose and Administration:

ADULT

Anaphylaxis/Allergic Reactions and Motion Sickness:
Oral:
- **25-50mg** every 6-8 hours

IV Push:
- **50mg** once, prepare to administer epinephrine

Acute Hemolytic reaction (rapid onset of itching, chills, flushing, nausea/vomiting, coughing, wheezing, laryngeal edema, dyspnea, hypotension hemoglobinuria, rise in venous pressure, distended neck veins, crackles in lung bases):
IV:
- **50mg** once, after administration of epinephrine 0.5mL in lateral thigh

PEDIATRIC Always Reference BROSELOW Tape

Anaphylaxis/Allergic Reactions and Motion Sickness:
Oral, IM, IV:
- **1 mg/kg** every 6 hours

Max Doses:
2 to <6 years:
- **6.25mg** every 4-6hrs; max of 37.5mg/day

6 to <12 years:
- **12.5-25mg** every 4-6hrs; max of 150mg/day

≥12 years:
- See Adult dosing

DOBUTAMINE

♀B, **Lactation?** (Caution) Trade Name: **Dobutrex**

Class / Mechanism of Action

Adrenergic Agonist
Positive Inotropic agent. Stimulates beta1 adrenergic receptors: Increases HR and contraction force while sparing beta2 and alpha receptors. Onset IV: 1-2 minutes

Indications

Labeled Indications: Short term management of cardiac decompensation.

Contraindications

- Hypersensitivity to dobutamine or sulfites (some contain sodium metabisulfate), or any component of the formulation
- Idiopathic hypertrophic subaortic stenosis (IHSS)

Adverse Reactions / Precautions

- **Always attempt to correct Hypovolemia 1st when using vasopressors and/or inotropes**
  - **May be combined with Dopamine or Norepinephrine for hypotension not responding to fluid administration**
  - **No applicable use in hemorrhagic shock until fluid replacement therapy maximized!**
- Increase in BP is common, but does have a rare incidence of causing hypotension
- Increases HR
- May exaggerate ventricular ectopy

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Cardiac Decompensation:

IV:
Dobutamine may be combined with dopamine or norepinephrine for hypotension not responsive to fluid therapy.

- **2-20 mcg/kg/min**, start low and titrate to targeted MAP > 60 mmHg

- **Preparation:** Mix 250mg Dobutamine in 250mL D5W or NS for a concentration of 1000mcg/mL

Infusion Rates for Dobutamine at 1000mcg/mL

Desired Delivery Rate (mcg/kg/min)	Infusion Rate (mL/kg hour)
2.5	0.15
5	0.3
7.5	0.45
10	0.6
12.5	0.75
15	0.9
20	1.2

Cardiac Decompensation:

IV

- Refer to adult dose

DOPAMINE

♀C, **Lactation?** (Use Caution)

Trade Name: **Intropin**

Class / Mechanism of Action

Adrenergic Agonist; Vasopressor

Stimulates adrenergic and dopaminergic receptors. High doses stimulate dopaminergic and beta1 adrenergic receptors, producing cardiac stimulation and renal vasodilation. Very large doses stimulate alpha adrenergic receptors.

Indications

Labeled Indications:

Treatment of non-hemorrhagic shock (e.g. neurogenic, renal failure, cardiac decompensation) persisting after adequate fluid volume replacement

Unlabeled: Symptomatic bradycardia or heart block unresponsive to atropine or pacing

Contraindications

- Hypersensitivity to sulfites
- Ventricular Fibrillation

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Tachycardia and/or Arrhythmias: May increase HR and worsen arrhythmias
- Vesicant: Avoid extravasation, will cause tissue damage/necrosis
- Assure adequate circulatory volume to minimize need for vasoconstrictors. Monitor BP closely, avoid hypertension and adjust infusion rate as needed.

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Hemodynamic Support:

IV(Use microdrip chamber only):

- **5-20mcg/kg/min**; titrate to desired response. Infusion may be increased by 1-4mcg/kg/minute at 10 to 30 minute intervals until optimal response is obtained

Dopamine Dosage Efficacy:

- 1-5 mcg/kg/min= Dopaminergic effects: increased urine output, increased renal blood flow
- 5-10 mcg/kg/min= Beta1 effects: Increased CO, HR, and contractility
- >10 mcg/kg/min= Alpha1 effects: Increased BP, vasoconstriction

Note: Doses >20 mcg/kg/minute likely do not have a beneficial effect on blood pressure and may increase risk of tachyarrhythmias
Add additional vasopressor if Dopamine doses of 20 mcg/kg/min are inadequate. (**phenylephrine**, **norepinephrine**, **epinephrine**.

Hemodynamic Support:

IV:

- "Use adult dosing"

Note: Dopamine is a second line medication for hemodynamic support in Pediatric patients behind Epinephrine and Norepinephrine

Dopamine						
Dosing Range: 5-20mcg/kg/min (300-1200mcg/kg/hr)						
MIX 800 mg/500 mL CONCENTRATION 1600 mcg/mL						
Pt. Weight	Dose	Rate	Micro (60	Macro		
				20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
50	5	9	9	3	2	2
	10	19	19	6	5	3
	15	28	28	9	7	5
	20	38	38	13	10	6
55	5	10	10	3	3	2
	10	21	21	7	5	4
	15	31	31	10	8	5
	20	41	41	14	10	7
60	5	11	11	4	3	2
	10	23	23	8	6	4
	15	34	34	11	9	6
	20	45	45	15	11	8
65	5	12	12	4	3	2
	10	24	24	8	6	4
	15	37	37	12	9	6
	20	49	49	16	12	8
70	5	13	13	4	3	2
	10	26	26	9	7	4
	15	39	39	13	10	7
	20	53	53	18	13	9
75	5	14	14	5	4	2
	10	28	28	9	7	5
	15	42	42	14	11	7
	20	56	56	19	14	9
Micro-Drip is set of choice for this infusion						
Titrate to minimum effective dose. Allow 3-5 minutes between dosing changes to assess hemodynamic effects.						

Dopamine						
Dosing Range: 5-20mcg/kg/min (300-1200mcg/kg/hr)						
MIX 800 mg/500 mL CONCENTRATION 1600 mcg/mL						
Pt. Weight	Dose	Rate	Micro (60	Macro		
				20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
80	5	15	15	5	4	3
	10	30	30	10	8	5
	15	45	45	15	11	8
	20	60	60	20	15	10
85	5	16	16	5	4	3
	10	32	32	11	8	5
	15	48	48	16	12	8
	20	64	64	21	16	11
90	5	17	17	6	4	3
	10	34	34	11	9	6
	15	51	51	17	13	9
	20	68	68	23	17	11
95	5	18	18	6	5	3
	10	36	36	12	9	6
	15	53	53	18	13	9
	20	71	71	24	18	12
100	5	19	19	6	5	3
	10	38	38	13	10	6
	15	56	56	19	14	9
	20	75	75	25	19	13
105	5	20	20	7	5	3
	10	39	39	13	10	7
	15	59	59	20	15	10
	20	79	79	26	20	13
Micro-Drip is set of choice for this infusion						
Titrate to minimum effective dose. Allow 3-5 minutes between dosing changes to assess hemodynamic effects.						

EPINEPHRINE 1mg/mL (formerly 1:1000)

♀C, **Lactation?** (Caution)

Trade Name: **EpiPen / EpiPen Jr**

Class / Mechanism of Action

Alpha & Beta Agonist

Sympathomimetic, stimulates both alpha and beta adrenergic receptors, causing relaxation of the bronchial tree, cardiac stimulation (increasing myocardial oxygen consumption), and dilation of skeletal muscle blood vessels

Indications

- Allergic Reactions, Anaphylaxis
- Asthma (Bronchoconstriction)

Contraindications

- Not for IV use, must first dilute into 10mL NS syringe for Cardiac / IV use

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Chest Pain, Tachycardia, Arrhythmias, Palpitations, Sudden death
- Anxiety, Cerebral Hemorrhage, Headache
- Vesicant: Avoid extravasation, will cause tissue damage/necrosis
- Use with caution in patients taking tricyclic antidepressants; effects of epinephrine may be increased

Dose and Administration:

ADULT

Bronchodilator:

SubQ, IM: **1mg/mL**

- **0.3-0.5 mg** every 20 minutes for 3 doses

Nebulization:

- Add **0.5 mL** to nebulizer and dilute with 3 mL of NS; administer over 15 minutes

Anaphylaxis / Hypersensitivity reaction (ALS,2020):

IM: **1mg/mL**

- **0.3-0.5 mg** every 5-15 minutes until clinical improvement

IV Infusion:

- Initiate with an infusion at **5-15 mcg/minute** (with crystalloid) (See infusion chart next page)

Acute Hemolytic reaction

IM: **1mg/mL**

- **0.5mg** IM in lateral thigh
  - Repeat every 5-15min for moderate bronchospasm or facial/laryngeal edema.
- Follow with Diphenhydramine 50mg IV Push

PEDIATRIC Always Reference BROSELOW Tape

Bronchodilator:

SubQ: Infants and Children **1mg/mL**

- **0.01 mg/kg** (0.01 mL/kg) (maximum single dose: 0.5 mg) every 20 minutes for 3 doses

Nebulization:

- Children <4 years: Croup: **0.05 mL/kg** (maximum dose: 0.5 mL); dilute in 3 mL of NS. Administer over 15 minutes; do not administer more frequently than every 2 hours
- Children ≥4 years: Adult dosing

Anaphylaxis / Hypersensitivity reaction (PALS,2020): Infants and Children

IM:

- **0.01 mg/kg** (0.01 mL/kg of **1mg/mL** solution) (maximum single dose: 0.3 mg) every 5-15 minutes

EpiPen Jr, Children <15kg:

- **0.15 mg**; if anaphylactic symptoms persist, dose may be repeated in 5-15 minutes using an additional EpiPen Jr

EpiPen, Children ≥15 kg:

- **0.3 mg**; if anaphylactic symptoms persist, dose may be repeated in 5-15 minutes using an additional EpiPen

Epinephrine 1mg/1ml (1:1,000)					
Anaphylaxis					
Dosing Range: 5-15mcg/min (150-450mcg/hr)					
MIX 1 mg/500 mL CONCENTRATION 2 mcg/mL					
Dose	Rate	Micro (60	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mcg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
5	150	150	50	38	25
6	180	180	60	45	30
7	210	210	70	53	35
8	240	240	80	60	40
9	270	270	90	68	45
10	300	300	100	75	50
11	330	330	110	83	55
12	360	360	120	90	60
13	390	390	130	98	65
14	420	420	140	105	70
15	450	450	150	113	75
Macro-Drip (10gtt/ml) is set of choice for this infusion					
Start at lowest dose and titrate to desired effect					

EPINEPHRINE

♀C, **Lactation?** (Caution)

Trade Name: **Adrenalin**

1mg/10mL (formerly 1:10,000)

Class / Mechanism of Action

Alpha & Beta Agonist

Sympathomimetic, stimulates both alpha and beta adrenergic receptors, causing relaxation of the bronchial tree, cardiac stimulation, and dilation of skeletal muscle blood vessels

Indications

- Cardiac Arrest (VF, pulseless VT, asystole, PEA)
- Drip-Dose: Bradycardia (Symptomatic), Fluid Resistant Shock
- Push-Dose: Bradycardia, Hypotension, Refractory Anaphylaxis

Contraindications

- Uncontrolled hypertension is a relative contraindication, otherwise none

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Chest Pain, Tachycardia, Arrhythmias, Palpitations, Sudden death
- Anxiety, Cerebral Hemorrhage, Headache
- Vesicant: Avoid extravasation, will cause tissue damage/necrosis
- Use with caution in patients taking tricyclic antidepressants; effects of epinephrine may be increased

Dose and Administration:

ADULT

Asystole/pulseless arrest, pulseless VT/VF:

IV: **1mg/10mL** (0.1mg/mL) Pre-filled 10cc Syringe

- **1 mg** (10cc of 0.1mg/mL) every 3-5 minutes to ROSC, Follow each with 20mL flush

Drip-Dose: Bradycardia (Symptomatic), Fluid Resistant Shock:

IV Continuous Infusion:

- **2-20 mcg/minute** titrate to desired effect (HR >60, MAP >65)

Push-Dose: Bradycardia, Hypotension, Refractory Anaphylaxis:

IV/IO: Mix 100mcg (1mL of 1mg/10mL) Epinephrine in 10cc NS for concentration of 10mcg/mL

- **5-20mcg IV/IO push q 2-5min, titrate to desired response**

PEDIATRIC Always Reference BROSELOW Tape

Asystole, PEA, pulseless VT/VF, Unresponsive and Symptomatic Bradycardia in Infants

IV: **1mg/10mL –** 0.1mg/mL Pre-filled 10cc Syringe

- **0.01 mg/kg** (0.1 mL/kg of **1mg/10mL** [0.1 mg/mL]) (maximum single dose: 1 mg) every 3-5 minutes as needed or until ROSC

Severe Hypotension/shock and fluid resistant (unlabeled use):

IV: Continuous Infusion

- **0.1 - 1 mcg/kg/minute** titrated to desired effect

Epinephrine 1mg/10ml (1:10,000)					
Pressor for Hypotension					
Dosing Range: 2-20mcg/min (120-600mcg/hr)					
MIX 1 mg/500 mL CONCENTRATION 2 mcg/mL					
Dose	Rate	Micro (60	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mcg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
2	60	60	20	15	10
3	90	90	30	22.5	15
4	120	120	40	30	20
5	150	150	50	37.5	25
6	180	180	60	45	30
7	210	210	70	52.5	35
8	240	240	80	60	40
9	270	270	90	67.5	45
10	300	300	100	75	50
11	330	330	110	82.5	55
12	360	360	120	90	60
13	390	390	130	97.5	65
14	420	420	140	105	70
15	450	450	150	112.5	75
16	480	480	160	120	80
17	510	510	170	127.5	85
18	540	540	180	135	90
19	570	570	190	142.5	95
20	600	600	200	150	100
Macro-Drip (10gtt/ml) is set of choice for this infusion					
Start at lowest dose and titrate to desired effect					

Ertapenem	♀C, **Lactation Yes**	Trade Name: **Invanz**

Class / Mechanism of Action

Antibiotic (Carbapenem),
Biacteriocidal – broad spectrum, Inhibits bacterial cell wall synthesis by binding to one or more of penicillin-binding proteins which inhibits cell wall biosynthesis, causing bacteria to eventually lyse.

Labeled Indications: Used for infection control prophylaxis for traumatic open injuries and surgical prophylaxis.

Contraindications

- Hypersensitivity to cefazolin, other cephalosporin antibiotics, other beta-lactams, or any component of the formulation

Adverse Reactions / Precautions

- Superinfection – prolonged use may result in fungal or bacterial superinfection (including C.Difficile)

Dose and Administration: ADULT	**PEDIATRIC**

Infection Control:
Give 1g in 250 mL NS IV over 5 min, provides 24 hours of coverage.
 	
IV:
Adults:
• 1 g IV every 24 hrs
  ○ Max daily dose: 12 g/day
	Infection Control: Children <12 years & ≥12 years
	
	IV:
	Pediatrics:
	• <12years old: 15 mg/kg IV every 12 hrs
	  ○ Max daily dose: 100 mg/kg/day
	
	• ≥12 years old: 20 mg/kg IV or IM once daily
	  ○ Max daily dose: 1 g/day

ETOMIDATE

♀C, **Lactation?** (Caution)

Trade Name: **Amidate**

Class / Mechanism of Action

General Anesthetic

Very short acting non-barbiturate sedative/hypnotic used for induction of anesthesia with little cardiovascular effects. Onset of action: 30-60 seconds, Duration 5-10 minutes

Indications

Labeled Indications:

- Rapid Sequence Induction

Contraindications

- Hypersensitivity to etomidate or any component of the formulation

Adverse Reactions / Precautions

- **NO Analgesic properties!**
- Safety in children less than 10 years has not been established
- Inhibits adrenal steroid production; may increase mortality if repeat dosing is required

Dose and Administration:

ADULT	PEDIATRIC Always Reference BROSELOW Tape
RSI: IV: • **0.3 mg/kg** over 30-60 seconds for induction of anesthesia; **Note:** Limit to single dose for anesthesia/induction. Repeat dosing and continuous infusion (maintenance dosing) may increase patient mortality due to adrenal suppression and inability to respond to stress.	**RSI:** IV: Children <10 • Despite dosing on Broselow tape, not the preferred induction agent for this group due to limited safety information Children >10: • **0.3 mg/kg** over 30-60 seconds will produce rapid sedation lasting 10-15 minutes. ○ Max dose: 20 mg **Note:** Limit to single dose for anesthesia/induction. Repeat dosing and continuous infusion (maintenance dosing) may increase patient mortality due to adrenal suppression and inability to respond to stress.

FENTANYL

♀C, **Lactation Yes** (Not recommended) Trade Name: **Sublimaze**

Class / Mechanism of Action

Opioid Analgesic; General Anesthetic

Binds to opioid receptors within the CNS increasing pain threshold and altering pain reception; inhibits ascending pain pathways (blocking painful stimulus); produces CNS depression

Onset: IV almost immediate, Duration: IV 0.5-1 hour

Indications

Labeled Indications:

- Pain relief
- Adjunct to general or regional anesthesia

Contraindications

- Hypersensitivity to fentanyl or any component of the formulation

Adverse Reactions / Precautions

- When using only as pain med and not adjunct to general anesthesia, ensure Slow IV Push (3-5 min). Rapid infusion may result in chest wall rigidity, impaired ventilation, or respiratory distress/arrest Always be prepared for use of paralytic and intubation (positive control of airway).
- **Head trauma: Use with extreme caution in head injury, or suspected increased ICP; exaggerated increase in ICP may occur if patient management is inadequate.**
- May worsen Bradycardia
- May cause life-threatening hypoventilation and Reparatory depression
- CNS depression: Impairs physical and mental abilities

Dose and Administration:

ADULT

Pain Management:

IV: Slow (Unlabeled)

- **0.5-1mcg/kg** PRN for breakout pain q 30-60 min

IN:

- **100 mcg**

Note: Patients with prior opioid exposure may have increased tolerance and require higher dosing

Sedation during mechanical ventilation:

IV:

- Initial Bolus: **1-2mcg/kg**

Continued Sedation:

- **0.5-1mcg/kg/hr** infusion (See Infusion chart next page)

(Combine with 0.05-0.1mg/kg Midazolam for best effect)

- **0.5-2mcg/kg** IVP q 30-60min

Pretreatment for RSI:

3-5 min prior to RSI in pt's with Head injuries, Increased ICP, Cardiac Ischemia or Aortic Dissection (if situation allows):

- **3mcg/kg** slow IV push

Non-Traumatic Chest Pain (Cardiac)

- **25-50mcg** IV

PEDIATRIC Always Reference BROSELOW Tape

Pain Management:

IV: Slow (Unlabeled)

- **0.5-1mcg/kg** PRN for breakout pain q 30-60 min

Sedation during mechanical ventilation:

IV:

- Initial Bolus: **1-2mcg/kg**
- Continued Sedation: **0.5-2mcg/kg** q 30-60min or **0.5-2mcg/kg/hr** infusion

(Combine with 0.05-0.1mg/kg Midazolam for best effect)

Note: Titrate doses and intervals to pain relief/prevention. Monitor vital signs.

- Single IV doses last 0.5-1 hour

FENTANYL (SUBLIMASE)					
Dosing Range: 0.5-1 mcg/kg/hr					
MIX 1 mg/100 mL CONCENTRATION 10 mcg/mL					
Dose	Rate	Micro (60 gtt/mL)	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mcg/hr	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
25	3	3	1	1	0
30	3	3	1	1	1
35	4	4	1	1	1
40	4	4	1	1	1
45	5	5	2	1	1
50	5	5	2	1	1
55	6	6	2	1	1
60	6	6	2	2	1
65	7	7	2	2	1
70	7	7	2	2	1
75	8	8	3	2	1
80	8	8	3	2	1
85	9	9	3	2	1
90	9	9	3	2	2
95	10	10	3	2	2
100	10	10	3	3	2
105	11	11	4	3	2
110	11	11	4	3	2
115	12	12	4	3	2
120	12	12	4	3	2
125	13	13	4	3	2
130	13	13	4	3	2
135	14	14	5	3	2
140	14	14	5	4	2
145	15	15	5	4	2
150	15	15	5	4	3
155	16	16	5	4	3
160	16	16	5	4	3
165	17	17	6	4	3
170	17	17	6	4	3
175	18	18	6	4	3
180	18	18	6	5	3
185	19	19	6	5	3
190	19	19	6	5	3
195	20	20	7	5	3
200	20	20	7	5	3
Micro-Drip is set of choice for this infusion					
Sample patient: 80kg pt at 0.5-1mcg/kg/hr = 40mcg/hr-80mcg/hr dosing range					

FUROSEMIDE

♀C, **Lactation Yes** (Caution)

Trade Name: **Lasix**

Class / Mechanism of Action

Antihypertensive; Loop Diuretic

Inhibits reabsorption of sodium and chloride in the kidney, causing increased loss of water, sodium, chloride, magnesium, and calcium within urine. When given IV it also causes rapid venous dilation. Symptomatic improvement of acute pulmonary edema approximately 15-20 minutes

Indications

Labeled Indications: Management of edema associated with heart failure and hepatic or renal disease;

- Management of edema associated with heart failure and hepatic or renal disease; acute pulmonary edema
- Hypertension (alone or in combination with other antihypertensives)

Contraindications

- Hypersensitivity to furosemide or any component of the formulation
- Anuria **(No pre-hospital utility in hypovolemic shock)**

Adverse Reactions / Precautions

- Can cause profound diuresis with resulting shock and electrolyte depletion. Monitor closely
  - May cause: Hypovolemia, Hypotension, hyponatremia, hypokalemia
- May potentiate effect of additional antihypertensives

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Acute pulmonary edema:

IV

- **40 mg** over 1-2 minutes. If response not adequate within 1 hour, may increase dose to 80 mg

Edema, heart failure:

IV, IM:

- Initial: **20-40 mg/dose**; if response is not adequate, may repeat the same dose or increase dose in increments of 20 mg/dose and administer 1-2 hours after previous dose (maximum dose: 200 mg/dose).

Continuous IV Infusion:

- Initial: IV bolus dose **20-40 mg** over 1-2 minutes, followed by continuous IV infusion doses of **10-40 mg/hour**. If urine output is <1 mL/kg/hour, double as necessary to a maximum of 80-160 mg/hour.

Edema, heart failure: Infants and Children

IV, IM:

- Initial: **1 mg/kg/dose**; if response not adequate, may increase dose in increments of 1 mg/kg/dose and administer not sooner than 2 hours after previous dose, until a satisfactory response is achieved; may administer maintenance dose at intervals of every 6-12 hours; maximum dose: 6 mg/kg/dose

GLUCAGON ♀B, Lactation? (Caution)

Class / Mechanism of Action

Antidote, Hypoglycemia Antidote, Diagnostic agent
Raises blood glucose levels by stimulating increased production of cyclic AMP, promoting hepatic glycogenolysis and gluconeogenesis

Indications

Labeled Indications: Management of hypoglycemia (Glucose <70 in adults or <60 in children)
Unlabeled:

- Beta-blocker or calcium channel blocker induced myocardial depression (with or without hypotension) unresponsive to standard measures
- Hypoglycemia secondary to insulin or sulfonylurea overdose (as adjunct to dextrose)

Contraindications

- Hypersensitivity to glucagon or any component of the formulation
- Insulinoma / Pheochromocytoma

Adverse Reactions / Precautions

- Should NOT be used as 1st line medication for hypoglycemia or Altered mental status
  - **Hypoglycemia patients should receive dextrose**. If IV access cannot be established or if dextrose is not available, glucagon may be used as alternate until dextrose can be given.
- Thiamine should precede use in patient with suspected alcoholism or malnutrition

Dose and Administration: **ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
Hypoglycemia: IV, IM, SubQ: • **1 mg**; may repeat in 20 minutes as needed **Beta-blocker / Calcium channel blocker overdose (myocardial depression)** unresponsive to standard measures (unlabeled use): IV: **(ACLS, 2015)** • **3-10 mg** (or 0.05-0.15 mg/kg) bolus followed by an infusion of 3-5 mg/hour (or 0.05-0.1 mg/kg/hour); titrate infusion rate to achieve adequate hemodynamic response	***Hypoglycemia:** IV, IM, SubQ: • **Children <20 kg: 0.5 mg** or 20-30 mcg/kg/dose; repeated in 20 prn. • Children ≥20 kg: Adult dosing. **Note:** IV dextrose should be given ASAP; if patient fails to respond to glucagon, IV dextrose must be given ***Only use if hyperinsulinemia thought to be cause of hypoglycemia (rare in kids). If hypoglycemic without glycogen stores, Glucagon will be ineffective.** **Beta-blocker / Calcium channel blocker overdose (myocardial depression)** unresponsive to standard measures (unlabeled use): IV: • **30-150mcg/kg** bolus. Can be repeated if no response in 15 min. Follow with an infusion of 20-70mcg/kg/hr; titrate infusion rate to achieve adequate hemodynamic response

HEPARIN

♀C, Lactation No

Trade Name:

Class / Mechanism of Action

Anticoagulant

Inactivates thrombin and activated coagulation factors (IX, X, XI, XII, and plasmin) and prevents conversion of fibrinogen to fibrin.

Indications

Labeled Indications: Treatment of thromboembolic disorders

Unlabeled: ST elevation MI (STEMI) as an adjunct to thrombolysis; unstable angina/non-STEMI

Contraindications

- Hypersensitivity to heparin or any component of the formulation
- Active Bleeding (Trauma Patient)

Adverse Reactions / Precautions

- Continuously monitor for bleeding: Stop immediately if any bleeding occurs
- Urticarial reactions and anaphylaxis can occur

Dose and Administration:

ADULT

Acute coronary syndromes: STEMI/Unstable Angina as an adjunct to fibrinolysis (full-dose alteplase**:**

IV:

- Initial bolus of **60 units/kg** (MAX: 4000 units)
  - Maintenance: 12 units/kg/hour (MAX: 1000 units/hour) as continuous infusion.

Treatment of venous thromboembolism:

IV: (unlabeled dosing)

- DVT/PE: **80 units/kg** (or alternatively 5000 units) IV push followed by continuous infusion of 18 units/kg/hour

Note: Heparin is ONLY for use only under written direction of referring provider or direct consultation with medical director.

PEDIATRIC Always Reference BROSELOW Tape

Treatment of venous thromboembolism:

IV: (unlabeled dosing)

>1 year

- DVT/PE: **75 units/kg** IV push followed by continuous infusion of 20 units/kg/hour

HETASTARCH

♀C, **Lactation Yes** (Caution)

Trade Name: **Hextend**

Class / Mechanism of Action

Plasma Volume Expander, Colloid

Colloidal starch producing plasma volume expansion. Onset of Action: approximately 30 minutes

Indications

Labeled Indications: Volume expander used in treatment of hypovolemic / hemorrhagic shock

Contraindications

- Hypersensitivity to hydroxyethyl starch or any component of the formulation
- Renal failure with oliguria and anuria (not related to Hypovolemia)
- Fluid overload conditions, (pulmonary edema, congestive heart failure
- Pre-existing bleeding or coagulation disorders (eg, von Willebrand's disease): Use caution in bleeding disorders; may increase risk of more bleeding

Adverse Reactions / Precautions

- Anaphylactoid reactions (allergies to corn)

Dose and Administration:	**ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
Plasma volume expansion: IV • **250-500ml** Bolus. May repeat PRN (up to 1500 mL/day). Titrate to individual hemodynamic needs (Sys BP >90). **Notes:** • May be administered via infusion pump or pressure infusion. • Do not administer with blood through the same line / tubing • Change tubing or flush extensively with NS before administering blood through the same line.		

HYDROMORPHONE ♀C, Lactation Yes(Not Recommended) Trade Name: **Dilaudid**

Class / Mechanism of Action

Opioid Analgesic

Binds to opioid receptors within the CNS increasing pain threshold and altering pain reception; inhibits ascending pain pathways (blocking painful stimulus); produces CNS depression

Onset: IV 10-20 minutes. Duration 2-4 hours

Indications

Labeled Indications: Moderate to severe pain.

Contraindications

- Hypersensitivity to hydromorphone or any component of the formulation
- Severe respiratory depression (in absence of resuscitative equipment or ventilator support)
- Acute or severe asthma
- Paralytic ileus

Adverse Reactions / Precautions

- Always be prepared for use of paralytic and intubation (maintain positive control of airway).
- **Head trauma: Use with extreme caution in head injury, or suspected increased ICP; exaggerated increase in ICP may occur.**
- May cause Hypotension, Use with caution in hypovolemic patients.
- May cause life-threatening Reparatory depression
- CNS depression: Impairs physical and mental abilities

Dose and Administration: **ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
Acute pain (moderate-to-severe): IV: (Slow) • **0.5mg (range 0.25-2mg) IV/IO q 1-6hr as prn** • **Critically ill require lower dose, opioid tolerant may require higher dose** • Continuous infusion: Usual dosage range: **0.5-3 mg/hour (See infusion chart next page)**	**Acute pain (moderate-to-severe):** IV: (Slow) • Children: **0.015mg/kg** IV q 4-6 PRN • Adolescents >50kg: Refer to adult dosing

HYDROMORPHONE (DILAUDID)					
Dosing Range: 0.5-3mg/hr (8.3-50mcg/min)					
MIX 2 mg/100 mL CONCENTRATION 20 mcg/mL					
Dose	Rate	Micro (60	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mg/hr	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
0.5	25	25	8	6	4
1	50	50	17	13	8
1.5	75	75	25	19	13
2	100	100	33	25	17
2.5	125	125	42	31	21
3	150	150	50	38	25
Macro-Drip (20gtt/ml) or Micro-Drip is set of choice for this infusion					
Start at lowest dose and increase rate by 0.5mg/hr PRN for appropriate pain management					

HYDROXOCOBALAMIN ♀C, Lactation? (Caution) Trade Name: **Cyanokit®**

Class / Mechanism of Action

Antidote; Vitamin

Precursor to Vitamin B_{12} (cyanocobalamin). Binds cyanide ion to form cyanocobalamin which is excreted within urine

Indications

Labeled Indications:

- IM: Treatment of pernicious anemia and B12 deficiencies
- IV: (Cyanokit®) Treatment of known or suspected cyanide poisoning

Contraindications

- No contraindications when treating for suspected or known cyanide poisoning

Adverse Reactions / Precautions

- May cause transient hypertension (≥180mmHG systolic, ≥110mmHG diastolic)
- Will cause red colored urine and skin

Dose and Administration:

ADULT

Cyanide Poisonings:

IV (**Note:** If cyanide poisoning is suspected, antidotal therapy must be given immediately)

- Initial: **5 grams** as single infusion given over 15 min
  - Repeat a second 5 gram dose based on severity and clinical response.
  - Maximum cumulative dose: 10 grams

Smoke Inhalation / Fire victims: (Closed space exposure with evidence of airway injury: soot in mouth / nose / sputum)

- May present with both cyanide and carbon monoxide poisoning. Hydroxocobalamin is the agent of choice for treating cyanide toxicity in this setting.

Preparation:

Cyanokit®: Reconstitute each vial with 200 mL of NS (LR and D5W also OK).

- Do not shake vial (gently mix)
- Do not use if solution is not dark red

PEDIATRIC Always Reference BROSELOW Tape

Cyanide Poisonings:

IV: (Unlabeled Use)

- Initial: **70mg/kg (max 5 grams)** as single infusion given over 15 min
  - Repeat a second dose of 35mg/kg based on severity and clinical response.

Smoke Inhalation / Fire victims: (Closed space exposure with evidence of airway injury: soot in mouth / nose / sputum)

- May present with both cyanide and carbon monoxide poisoning. Hydroxocobalamin is the agent of choice for treating cyanide toxicity in this setting.

KETAMINE

♀C, Lactation Yes (Risk not ruled out) Trade Name: **Ketalar**

Class / Mechanism of Action

General Anesthetic

Dissociative anesthetic; produces a cataleptic like state acting directly on the cortex and limbic system. Onset of action IV: 30-60 seconds; Duration is dose dependent averaging 10-20 minutes

Indications

Labeled Indications: Induction and maintenance of general anesthesia
Unlabeled: Analgesia and sedation

Contraindications

- Hypersensitivity to ketamine or any component of the formulation
- Conditions that cannot tolerate increases in blood pressure
  - E.g. spontaneous cerebral hemorrhage or acute coronary syndrome hypertension
- Children <3 mo age

Adverse Reactions / Precautions

- Rapid IV administration may cause hypotension, apnea, or laryngospasm. Large doses may cause hypotension and respiratory depression
- Use with caution in patients with cardiovascular disease. Continuously monitor cardiac function.
- **Preferred general anesthetic / sedative for hypo/normotensive head injury patient.**
- **Dosing between 0.5-0.9 mg/kg IV (and equivalent IM dose) can give patients the feeling of unreality leading to agitation and should be avoided.**

Dose and Administration:

ADULT

LOW DOSE:

Analgesia:

IV/IO Push (over 1 min)
- **0.1 - 0.2 mg/kg,** repeat q 10-30 prn

IM/IN
- **0.5 mg/kg,** repeat q 10-30 prn

HIGH DOSE:

RSI / Induction of anesthesia; Combative Patients:

IV Push
- **1-2 mg/kg**

IM
- **4-5 mg/kg**

Maintenance of anesthesia:

IV :
- **0.5-2 mg/kg** dose every 10-20 minutes

IV Continuous Infusion
- **0.5-2mg/kg bolus then 0.5-1 mg/kg/hr**. Titrate levels by 0.25mg/kg/hr PRN to achieve appropriate sedation. **(See infusion chart next page)**

PEDIATRIC Always Reference BROSELOW Tape

Analgesia:

IM:
- **0.5 mg/kg,** repeat q 10-30 prn

IV:
- **0.1 – 0.2 mg/kg,** repeat q 10-30 prn

Induction of anesthesia (unlabeled dosing):

IV:
- **1-2 mg/kg (3-5mg/kg for procedural sedation)**

Maintenance of anesthesia:

IV :
- **½ to Full induction dose** every 20-30 minutes

IV Continuous Infusion:
- **0.5-1 mg/kg/hr**. Titrate levels by 0.25mg/kg/hr PRN to achieve appropriate sedation.

NOTE Avoid sub-dissociative doses to prevent emergence phenomenon.

NOTE: *If patient experiences Ketamine Induced Agitation (Emergence Phenomena) give Midazolam 2-5mg IV x1 for adults and 0.05 mg/kg for children not hypotensive or in danger of being* hypotensive.

KETAMINE (KETALAR)						
Dosing Range: 1-3mg/kg/hr (17-50mcg/kg/min)						
MIX 500 mg/500 mL CONCENTRATION 1 mg/mL						
Pt. Weight	Dose	Rate	Micro	Macro		
			(60 gtt/mL)	20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
50	15	45	45	15	11	8
	20	60	60	20	15	10
	25	75	75	25	19	13
	30	90	90	30	23	15
	35	105	105	35	26	18
	40	120	120	40	30	20
	45	135	135	45	34	23
	50	150	150	50	38	25
	55	165	165	55	41	28
	60	180	180	60	45	30
55	15	50	50	17	13	8
	20	66	66	22	17	11
	25	83	83	28	21	14
	30	99	99	33	25	17
	35	116	116	39	29	19
	40	132	132	44	33	22
	45	149	149	50	37	25
	50	165	165	55	41	28
	55	182	182	61	46	30
	60	198	198	66	50	33
60	15	54	54	18	14	9
	20	72	72	24	18	12
	25	90	90	30	23	15
	30	108	108	36	27	18
	35	126	126	42	32	21
	40	140	140	47	35	23
	45	162	162	54	41	27
	50	180	180	60	45	30
	55	198	198	66	50	33
	60	216	216	72	54	36
65	15	60	60	20	15	10
	20	78	78	26	20	13
	25	98	98	33	25	16
	30	117	117	39	29	20
	35	137	137	46	34	23
	40	156	156	52	39	26
	45	176	176	59	44	29
	50	195	195	65	49	33
	55	215	215	72	54	36
	60	234	234	78	59	39
70	15	63	63	21	16	11
	20	84	84	28	21	14
	25	105	105	35	26	18
	30	126	126	42	32	21
	35	147	147	49	37	25
	40	168	168	56	42	28
	45	189	189	63	47	32
	50	210	210	70	53	35
	55	231	231	77	58	39
	60	252	252	84	63	42
75	15	68	68	23	17	11
	20	90	90	30	23	15
	25	113	113	38	28	19
	30	135	135	45	34	23
	35	158	158	53	40	26
	40	180	180	60	45	30
	45	203	203	68	51	34
	50	225	225	75	56	38
	55	248	248	83	62	41
	60	270	270	90	68	45
Macro-Drip is set of choice for this infusion						
Sample patient: 80kg pt at 1-3mg/kg/hr = 81-240mg/hr (81-240ml/hr)						

KETAMINE (KETALAR)						
Dosing Range: 1-3mg/kg/hr (17-50mcg/kg/min)						
MIX 500 mg/500 mL CONCENTRATION 1 mg/mL						
Pt. Weight	Dose	Rate	Micro	Macro		
			(60 gtt/mL)	20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
80	15	72	72	24	18	12
	20	96	96	32	24	16
	25	120	120	40	30	20
	30	144	144	48	36	24
	35	168	168	56	42	28
	40	192	192	64	48	32
	45	216	216	72	54	36
	50	240	240	80	60	40
	55	264	264	88	66	44
	60	288	288	96	72	48
85	15	77	77	26	19	13
	20	102	102	34	26	17
	25	128	128	43	32	21
	30	153	153	51	38	26
	35	179	179	60	45	30
	40	204	204	68	51	34
	45	230	230	77	58	38
	50	255	255	85	64	43
	55	281	281	94	70	47
	60	306	306	102	77	51
90	15	81	81	27	20	14
	20	108	108	36	27	18
	25	135	135	45	34	23
	30	162	162	54	41	27
	35	189	189	63	47	32
	40	216	216	72	54	36
	45	243	243	81	61	41
	50	270	270	90	68	45
	55	297	297	99	74	50
	60	324	324	108	81	54
95	15	90	90	30	23	15
	20	114	114	38	29	19
	25	143	143	48	36	24
	30	171	171	57	43	29
	35	200	200	67	50	33
	40	228	228	76	57	38
	45	257	257	86	64	43
	50	285	285	95	71	48
	55	314	314	105	79	52
	60	342	342	114	86	57
100	15	90	90	30	23	15
	20	120	120	40	30	20
	25	150	150	50	38	25
	30	180	180	60	45	30
	35	210	210	70	53	35
	40	240	240	80	60	40
	45	270	270	90	68	45
	50	300	300	100	75	50
	55	330	330	110	83	55
	60	360	360	120	90	60
105	15	95	95	32	24	16
	20	126	126	42	32	21
	25	158	158	53	40	26
	30	189	189	63	47	32
	35	221	221	74	55	37
	40	252	252	84	63	42
	45	284	284	95	71	47
	50	315	315	105	79	53
	55	347	347	116	87	58
	60	378	378	126	95	63
Macro-Drip is set of choice for this infusion						
Sample patient: 80kg pt at 1-3mg/kg/hr = 81-240mg/hr (81-240ml/hr)						

KETOROLAC

♀C, **Lactation Yes**(Caution)

Trade Name: **Toradol**

Class / Mechanism of Action

Nonsteroidal Anti-inflammatory Drug (NSAID)

Inhibits cyclooxygenase (COX 1 & 2) enzymes, which decreases production of prostaglandin precursors. Provides antipyretic, analgesic, and anti-inflammatory action.

Indications

Labeled Indications: Short term management of moderate to severe acute pain as an opioid alternative.

Contraindications

- Hypersensitivity to ketorolac, aspirin, other NSAIDs, or any component of the formulation.
- High risk of bleeding, recent history of GI bleeding or perforation, known history of peptic ulcer disease.
  - **Not for use as pain management for battlefield trauma patient!**
- Suspected cerebrovascular bleeding Dizziness, Flushing, Diaphoresis, Tremor, Weakness
- Risk of renal failure secondary to volume depletion
- Concurrent use with other NSAIDs

Adverse Reactions / Precautions

- Inhibits platelet function
- Associated with an increased risk of adverse cardiovascular thrombotic events, including MI and stroke
- May increase risk of GI irritation, inflammation, ulceration, bleeding, and perforation.
- May cause severe bronchospasm in patients with asthma
- May cause new onset hypertension or worsening of existing hypertension.

Dose and Administration:

ADULT

Pain management (acute; moderately severe):

Patients ≥50 kg

IM:

- **15-30 mg** every 6 hours (maximum daily dose: 120 mg)

IV:

- **15 mg** every 6 hours (maximum daily dose: 120 mg)

Adults ≥65 years and/or adults ≤50 kg

IM:

- **15-30 mg** every 6 hours (maximum daily dose: 60 mg)

IV:

- **15 mg** every 6 hours (maximum daily dose: 60 mg)

PEDIATRIC Always Reference BROSELOW Tape

Pain management (acute; moderately severe):

Adolescents >17 years only:

- Refer to adult dose

LABETALOL

♀C, **Lactation Yes** (Caution)

Trade Name: **Trandate**

Class / Mechanism of Action

Beta Blocker with alpha blocking activity

Blocks alpha and beta1/beta2 adrenergic receptor sites. Onset IV: 2-5 minutes

Indications

Labeled Indications: Treatment of hypertension.

- IV: Treatment of severe hypertension and hypertensive emergencies

Unlabeled:

- Pre-eclampsia and severe hypertension in pregnancy, hypertension during acute ischemic stroke, and Pediatric hypertension

Contraindications

- Hypersensitivity to labetalol or any component of the formulation
- **Bradycardia <60bpm, heart block >1st degree**
- Uncompensated heart failure, Cardiogenic shock
- Asthma

Adverse Reactions / Precautions

- Symptomatic hypotension with or without syncope, Monitor EKG closely
- Use with extreme caution in patients with compensated heart failure and Bradycardia
- Patient with bronchospastic diseases (reactive airway) should not use Beta blockers

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Acute Hypertension (hypertensive emergency/urgency:

Hypertensive Crisis
(Sys: >185/Dia: >110)

- **10-20 mg** IV over 1-2 minutes. May repeat one time

Continuous Infusion:

If continued medication required, **2-8mg/min**

Note: Goal to lower MAP by no more than 25% within minutes to one hour.

***Hypertension emergencies:**

IV Continuous Infusion

- 0.4-1 mg/kg/hour with a maximum of 3 mg/kg/hour have been used; administration requires the use of an infusion pump.
- Intermittent bolus doses of 0.3-1 mg/kg/dose have been reported

*Not 1st Line medication for children

Pearls:

For inter-facility transports with confirmed Ischemic CVA, Intraparenchymal Hemorrhagic CVA, or Spontaneous Non-traumatic SAH manage Hypertension according to diagnosis or guidance from sending facility

- Ischemic CVA Lytic ineligible: SBP < 220 and DBP <120
- Ischemic CVA Lytic eligible: SBP <185 and DBP <110
- Intraparenchymal Hemorrhagic CVA: SBP <180
- Non-traumatic SAH: SBP <160

LEVETIRACETAM ♀C, Lactation Yes (Caution) Trade Name: **KEPPRA**

Class / Mechanism of Action

Anticonvulsant

Causes modulation of synaptic neurotransmitter release through binding to the synaptic vesicle protein SV2A in the brain.

Indications

Labeled Indications

- Treatment of focal (partial) onset seizures

Unlabeled:

- Traumatic brain injury, severe acute (short-term seizure prophylaxis); Status epilepticus; Craniotomy, seizure prophylaxis; Subarachnoid hemorrhage (short-term seizure prophylaxis)

Contraindications

- Hypersensitivity to any component of the formulation

Adverse Reactions / Precautions

- May cause CNS depression
- Dermatologic reactions, possibly severe (TEN, SJS, etc)
- Hypertension has been reported in children <4 years
- Hematologic effects: Decreases in red blood cell counts, hemoglobin, hematocrit, white blood cell counts, and neutrophils and increases in eosinophils have been observed

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Traumatic brain injury (severe acute) (short-term seizure prophylaxis):

- Loading dose: 20 mg/kg (rounded to the nearest 250 mg) over 60 minutes
- Maintenance dose: 1,000 mg over 15 minutes every 12 hours for 7 days

Status epilepticus:

- IV: 1,000 to 3,000 mg administered at a rate of 2 to 5 mg/kg/minute **or** 40 to 60 mg/kg as a single dose infused over 15 minutes in combination with a parenteral benzodiazepine. Maximum dose: 4,500 mg.

Status epilepticus, refractory: (Limited data available)

Infants, Children, and Adolescents:

- IV: 20 to 60 mg/kg over 15 minutes as a single dose

LIDOCAINE

♀B, **Lactation Yes** (Caution) Trade Name: **Xylocaine (Cardiac)**

Class / Mechanism of Action

Antiarrhythmic
Suppresses automaticity of cardiac conduction tissue.

Indications

Labeled Indications: Acute treatment of ventricular arrhythmias from myocardial infarction (alternate to amiodarone when amiodarone not available)

Unlabeled: (ACLS, 2015)

- Hemodynamically stable monomorphic VT and polymorphic VT
- Pulseless VT / VF (unresponsive to defibrillation, CPR, and vasopressor administration)
- Monomorphic VT secondary to drug, when amiodarone is not available

Contraindications

- Hypersensitivity to lidocaine or any component of the formulation
- Prophylactic use in AMI
- Bradycardia, severe degrees of SA, AV, or intraventricular heart block
- Wolff-Parkinson-White syndrome, Adam-Stokes syndrome

Adverse Reactions / Precautions

- Continuous EKG monitoring is necessary
- Increased ventricular rate may be seen when given to a patient in AFib
- At high doses, monitor closely for CNS toxicity, seizure, depression, and respiratory depression.
  - D/C immediately if toxicity develops
- The elderly may have increased chance of CNS and cardiovascular side effects.

Dose and Administration: ADULT

Cardiac Arrest from VF/VT, (if Amiodarone is not available): (ACLS, 2015)**:**

IV, IO:

- Initial dose: **1 to 1.5mg/kg**
- For refractory VF may give additional **0.5 to 0.75mg/kg** IV push, repeat in 5 to 10 minutes
  - Maximum of 3 doses or total of 3mg/kg

Perfusing Arrhythmia (if amiodarone is not available): Stable VT, wide complex tachycardia, significant ectopy:

IV, IO

- Doses ranging from **0.5 to 0.75mg/kg and up to 1 to 1.5mg/kg.** Repeat 0.5 to 0.75mg/kg every 5 to 10 minutes
  - Maximum cumulative dose 3mg/kg

Flush after initiation of IO:

- May add 2-3 ml Lidocaine 2% (without epinephrine) to 5ml NS flush

Local Anesthesia during Tube/Finger Thoracostomy

- Draw 10ml 2% Lidocaine and locally anesthetize incision area.

Decompression Illness/ Arterial Gas Embolism:

- **1.5mg/kg** IV/IO

Dose and Administration: PEDIATRIC Always Reference BROSELOW Tape

VF/Pulseless VT, Wide Complex Tachycardia (with pulses): (PALS, 2015)

IV, IO:

- Initial dose**: 1mg/kg**

2015 AHA ACLS guidelines state:
"There is inadequate evidence to support the routine use of lidocaine after cardiac arrest. However, the initiation or continuation of lidocaine may be considered immediately after ROSC from cardiac arrest due to VF/pVT"

Maintenance Infusion (Adults and Peds):
IV, IO: Continuous Infusion

- **1-3 mg/hour** (or 20-50 mcg/kg/minute).

LORAZEPAM

♀D, **Lactation Yes** (not recommended) Trade Name: **Ativan**

Class / Mechanism of Action

Benzodiazepine
Acts as an Anxiolytic/Hypnotic, anticonvulsant and sedative.
Onset of action: IV Sedation 2-3 minutes; IM hypnotic, 15-30 minutes. Duration: IV, 8-12 hours.

Indications

Labeled Indications: Anesthesia premedication, Status epilepticus
Unlabeled:

- Rapid tranquilization of the combative / agitated patient
- Alcohol withdrawal delirium / syndrome
- Seizures
- Induce Sedation and Amnesia (Midazolam is primary medication)

Contraindications

- Hypersensitivity to Lorazepam or any component of the formulation or other benzodiazepines
- Acute narrow angle glaucoma, Acute Alcohol Intoxication, Sleep apnea
- Respiratory Insufficiency/Depression (except during mechanical ventilation)
  - Overdose Reversal: FLUMAZENIL **can be used, however it carries elevated risk. Respiratory support until the medication is metabolized is traditionally the best care in Benzodiazepine overdose**
- Neurologic Depression (Head Trauma) (unless having active seizure)

Adverse Reactions / Precautions

- **No Analgesic properties** (Narcotic pain control is needed for RSI'd / Intubated trauma patients)
- May Cause Respiratory depression: Do not give without stable IV line and BVM (airway control) ready
- Hypotension, vasodilation
- Amnesia, confusion, drowsiness, slurred speech (Paradoxical Reactions possible: aggressiveness, agitation, anxiety, inappropriate behavior)

Dose and Administration:

ADULT

Acute Seizures:
IV:

- **2-4mg** slow IV push, may repeat x2 every 3-5 minutes as needed.

Note: Not recommended IM for seizure due to erratic absorption.

Anxiety:

IV:

- 0.5-2mg slow IV push

Rapid tranquilization of agitated / combative patient (Off-label use):
IV, IM:

- **2-4mg** every 30-60 minutes**;** may be used alone or administered with an antipsychotic (i.e. haloperidol)

PEDIATRIC Always Reference BROSELOW Tape

Acute Seizures / Status epilepticus (unlabeled use):
IV:

- **0.05-0.1 mg/kg;** repeat doses every 5 minutes (max x2) for clinical effect. Max 4mg

Agitation:

- **0.05 mg/kg/dose** q 20-30 min PRN

MAGNESIUM SULFATE ♀D, Lactation Yes(Caution)

Class / Mechanism of Action

Anticonvulsant, Electrolyte Supplement

IV magnesium decreases acetylcholine in motor nerve terminals and slows rate of SA node impulse formation and prolongs conduction time. Magnesium functions to facilitate the movement of calcium, sodium, and potassium in and out of cells.

Indications

Labeled Indications:

- Prevention and treatment of seizures in pregnancies with severe pre-eclampsia or eclampsia
- Torsades de Pointes: Cardiac arrhythmias (VT/VF) cause by low serum magnesium

Contraindications

- Hypersensitivity any component of the formulation
- Myocardial damage and heart blocks
- Use for pre-eclampsia / eclampsia during 2 hour period before delivery

Adverse Reactions / Precautions

- Possible cardiovascular arrest, respiratory depression, and hypotension in large doses
- Hypomagnesaemia is often joined by hypokalemia and requires correction in order to normalize potassium.

Dose and Administration:

ADULT

Torsades de pointes or VF/pulseless VT associated with torsades de pointes (unlabeled use):
IV, IO:

- **1-2 g** over 15 minutes

Wheezing in Respiratory Distress (3rd line drug):
IV:

- **2 Grams** over 20min

Seizure (Refractory to Benzodiazepines):
IV:

- **1-2 Grams** over 30 min

Eclampsia/pre-eclampsia, severe (unlabeled):
IV:

- **4-6 g** over 15-20 minutes followed by 2 g/hour continuous infusion

PEDIATRIC Always Reference BROSELOW Tape

Torsades de pointes:
IV, IO:

- **25-50 mg/kg/dose** over several minutes
  - maximum single dose: 2000 mg

Respiratory Distress:
IV:

- **25-75 mg/kg** over 30 min (max 2 grams)

Magnesium Sulfate should be diluted into 50-100ml NS or D5W for all Adult and Pediatric infusions

MANNITOL 20% ♀C, Lactation? (Caution)

Class / Mechanism of Action

Osmotic Diuretic

Increases osmotic pressure of glomerular filtrate. This reduces kidney reabsorption of water and electrolytes and increases urinary output. Decreases cerebral blood volume and intracranial pressure (ICP) while increasing cerebral blood flow and O2 transport. Onset of action is 15-30 minutes

Indications

Labeled Indications:

- Reduction of increased ICP secondary to cerebral edema
- Reduction of elevated intraocular pressure
- Urinary excretion of toxic substances

Contraindications

- Hypersensitivity to mannitol or any component of the formulation
- Active intracranial bleeding
- Pulmonary congestion and edema
- Severe renal disease, or renal dysfunction after mannitol use
- Severe dehydration: (Do NOT use in **under-resuscitated or hypotensive casualties**)

Adverse Reactions / Precautions

- Chest pain, CHF, tachycardia, circulatory overload (with rapid administration), peripheral edema
- Headache, seizure
- Fluid and electrolyte imbalance, dehydration and hypovolemia
- Keep in a temperature controlled climate. Will crystalize at low temperatures.

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Moderate to severe head injury, *Patient continuing to deteriorate or showing signs of herniation despite adjustment to ventilation and starting hypertonic saline.*

IV

- **1 g/kg** IV bolus over <20 minutes.
- Follow with **0.25 g/kg** IVP every 4 hours

Vital Functions Goal in Head Injury (Prevention of secondary brain injury)**:**

- Keep SBP >90mmHg, MAP >60mmHg, and SaO2 >93%. [(CPP = MAP – ICP) Minimal goal CPP >60mmHg]

Note: Always have urinary catheter in place and monitor output.

Increased intracranial pressure (unlabeled dosing):

IV:

- **0.25-1 g/kg/dose**;
- Maintenance dose of **0.25-0.5 g/kg** IV q 4-6hrs prn to maintain serum osmolality <300-320 mOsm/kg

METHYLPREDNISOLONE ♀C, Lactation Yes(Caution) Trade Name: **SoluMedrol**

Class / Mechanism of Action

Systemic Corticosteroid
Anti-inflammatory, Immunosuppressant, shock

Indications

Labeled Indications: Treatment of a variety of diseases: allergic, inflammatory, hematologic, neoplastic, and autoimmune;
Unlabeled:
None identified unless added by medical direction.

Contraindications

- Hypersensitivity to methylprednisolone or any component of the formulation
- No other in emergency setting

Adverse Reactions / Precautions

- Not for use in treatment of head injury; increased mortality has occurred in head injury patients treated with high dose IV methylprednisolone.
- No immediate effect will be observed while treating in the pre-hospital environment. Onset of action may take several hours

Dose and Administration: ADULT	**PEDIATRIC** Always Reference BROSELOW Tape
Asthma exacerbations, including status asthmaticus IV: • **125mg** x 1 dose **Allergic Reaction:** IV: • **125mg** x 1 dose **Note:** Only methylprednisolone sodium succinate can be used for IV doses.	**Asthma exacerbations, including status asthmaticus** IV: • Children <12 years: **1-2 mg/kg** initial dose**;** followed by **0.5-1 mg/kg** q 6 hrs**.** (maximum: 60 mg/day) **Allergic Reaction** IV • **2 mg/kg** x 1 dose **Note:** Only methylprednisolone sodium succinate can be used for IV doses.

METOCLOPRAMIDE ♀B	Trade Name: Reglan

Class / Mechanism of Action

Prokinetic Agent: Antiemetic, Upper GI Stimulant
Potent dopamine-receptor antagonist. At higher doses blocks serotonin receptor in chemoreceptor trigger zones of CNS. Increases GI tract motility and gastric emptying. Onset of action 1-5 minutes via IV with a duration of 1-2 hours.

Indications

Labeled Indications: Prevention of postoperative nausea and vomiting; Acid Reflux/Heartburn/GERD; Migraine Headache

Contraindications

- Hypersensitivity to glucagon or any component of the formulation
- Insulinoma / Pheochromocytoma

Adverse Reactions / Precautions

- Hypersensitivity, History of tardive dyskinesia or dystonic reaction to Metoclopramide in the past, GI Obstruction or Hemorrhage, and seizure disorder (epilepsy).

Dose and Administration: ADULT	PEDIATRIC Always Reference BROSELOW Tape
5-10 mg IV/IO slow push; repeat dose x1 every 20-30 minutes PRN for a max of 20mg. *Rapid IV push may cause intense feelings of anxiety and restlessness* Ideal administration to Prevent Agitation/Adverse Effects: Dilute in a 50 or 100ml NS bag and infuse over 10-15 minutes.	**Not recommended or approved for routine pediatric use**

METOPROLOL

♀C, **Lactation?**(Not Recommended) Trade Name: **Lopressor**

Class / Mechanism of Action

Beta-1 Selective Beta-Blocker; Antihypertensive; Antianginal Agent

Selective inhibitor of $beta_1$-adrenergic receptors; competitively blocks $beta_1$-receptors, with little or no effect on $beta_2$-receptors at oral doses <100 mg (in adults); does not exhibit any membrane stabilizing or intrinsic sympathomimetic activity.

Onset of action: IV: 5 minutes, Duration 3-5 hours

Indications

Labeled Indications: Angina, Hypertension, Myocardial infarction

Unlabeled: Atrial fibrillation/flutter; Hypertrophic cardiomyopathy; Marfan syndrome with aortic aneurysm; Migraine prophylaxis; Supraventricular tachycardia (AVNRT, AVRT, focal atrial tachycardia); Thyrotoxicosis; Ventricular arrhythmias

Contraindications

- Hypersensitivity to metoprolol, any component of the formulation, or other beta-blockers; second- or third-degree heart block
- Severe sinus bradycardia (heart rate <45 beats/minute); significant first-degree heart block (P-R interval ≥0.24 seconds); systolic blood pressure <100 mm Hg; moderate to severe cardiac failure

Adverse Reactions / Precautions

- Cardiovascular: Hypotension, bradycardia, first degree atrioventricular block, arterial insufficiency, cardiac failure, CVA, cold extremities, palpitations, peripheral edema, claudication
- Central nervous system: Dizziness, fatigue, depression, vertigo, confusion, disturbed sleep, hallucination, headache, insomnia, nightmares, temporary amnesia, tinnitus

Dose and Administration: ADULT

Atrial fibrillation or atrial flutter (off-label use):

Acute ventricular rate control:

IV:

- 2.5 to 5 mg over 2-5 minutes; repeat dose every 5 minutes as needed; maximum total dose: 15 mg.

Supraventricular tachycardia/Ventricular arrhythmias (off-label use):

Note: For hemodynamically stable patients if vagal maneuvers and/or adenosine are unsuccessful.

IV:

- 2.5 to 5 mg over 2-5 minutes; repeat dose every 5 minutes as needed to achieve a ventricular rate of 90 – 100; maximum total dose: 15 mg.

Note: For sustained ventricular tachycardia, Beta-blockers are generally administered in addition to an antiarrhythmic drug (eg, Amiodarone) for these indications. A beta-blocker is also used to reduce shocks in patients who receive an implantable cardioverter defibrillator for these indications; propranolol may be the preferred beta-blocker in these situations

PEDIATRIC Always Reference BROSELOW Tape

Note: Guidelines do not recommend beta-blockers as initial therapy in pediatric patients; beta-blockers should be reserved for use in patients who have contraindications to preferred agents or after ≥2 preferred agents have failed in patients with hypertension and chronic kidney disease, proteinuria, or diabetes mellitus.

MIDAZOLAM

♀**D, Lactation Yes**(Caution)

Trade Name: **Versed**

Class / Mechanism of Action

Benzodiazepine

Acts as an Anxiolytic/Hypnotic, anticonvulsant and sedative.

Onset of action: Sedation; IV: 1-5 minutes, IM: 15 minutes, Intranasal: 4-8 minutes

Duration: IV, less than 2 hours. (20-30 Minutes per ECCN Nurse Protocols, May 2012)

Indications

Labeled Indications: Preoperative sedation, induction and maintenance of general anesthesia

Unlabeled: Anxiety / agitation, status epilepticus, conscious sedation (intranasal)

Contraindications

- Hypersensitivity to midazolam or any component of the formulation or other benzodiazepines
- Acute narrow angle glaucoma, Acute Alcohol Intoxication
- Respiratory Insufficiency/Depression (except during mechanical ventilation)
- (Overdose Reversal: **FLUMAZENIL can be used, however it carries elevated risk. Respiratory support until the medication is metabolized is traditionally the best care in Benzodiazepine overdose)**
- Should not be used in shock
- Neurologic Depression (Head Trauma) (unless having active seizure)

Adverse Reactions / Precautions

- **No Analgesic properties** (Narcotic pain control is needed for RSI'd / Intubated trauma patients)
- May Cause Respiratory depression: Do not give without stable IV line and BVM (airway control) ready
- Hypotension, vasodilation
- Amnesia, confusion, drowsiness, slurred speech (Paradoxical Reactions possible: aggressiveness, agitation, anxiety, inappropriate behavior)

Dose and Administration: ADULT

Induction for RSI; Continued sedation; Hyperthermia:

IV:

- **Induction 0.1mg/kg** IV/IO
- **Continued Sedation .05 mg** IV/IO
- **Infusion sedation** 0.05 mg/kg bolus IV, then titrate 0.05-0.1mg/kg/hr IV gtt

Transcutaneous Pacing / Cardioversion, Anxiety, Agitation,:

IV

- **2.5-5mg** q 15-30 PRN

Seizure Dosage:

- If no IV/IO access, **5mg IN** (repeat in 10 minutes in opposite nostril if still seizing (preferred) or **10mg IM** (alternate)
- **5mg IV/IO**, may repeat

After 3 doses should consider addition of another agent.

PEDIATRIC Always Reference BROSELOW Tape

Procedural sedation; Transcutaneous Pacing; Cardioversion:

IV:

- **0.05-0.1mg/kg** q 15-30 PRN

Intranasal (unlabeled route):

- **0.2-0.5 mg/kg** (maximum total dose: 10 mg or 5 mg per nare

Induction/RSI (Not preferred drug)

IV:

- **0.1-0.3 mg/kg**

Seizure

IV, IM:

- **0.2 mg/kg Q 15-30 PRN**

Status epilepticus, prehospital treatment (unlabeled use):

IV:

- Infants: **1-2 mg**
- 13-40 kg**: 4 mg once**
- >40 kg: Refer to adult dosing

MORPHINE

♀C, **Lactation Yes**(Caution)

Trade Name:

Class / Mechanism of Action

Opioid Analgesic

Binds to opioid receptors within the CNS increasing pain threshold and altering pain reception; inhibits ascending pain pathways (blocking painful stimulus); produces CNS depression

Onset: IV variable but rapid, Duration variable, patient dependent.

Indications

Labeled Indications: Moderate to severe acute and chronic pain; pain of myocardial infarction; preanesthetic medication

Contraindications

- Hypersensitivity to morphine sulphate or any component of the formulation
- Severe respiratory depression
- Acute or severe asthma (in an unmonitored setting or without resuscitative equipment)
- Paralytic ileus

Adverse Reactions / Precautions

- Always be prepared for use of paralytic and intubation (maintain positive control of airway).
- **Head trauma: Use with extreme caution in head injury, or suspected increased ICP; exaggerated increase in ICP may occur. Some formulations are specifically contraindicated.**
- May cause Hypotension, Use with caution in hypovolemic patients.
- May worsen Bradycardia
- May cause life-threatening hypoventilation and Reparatory depression
- CNS depression: Impairs physical and mental abilities

Dose and Administration:

ADULT

Chest Pain/AMI:

IV/IO:

- **2-5 mg** q 5-15 min PRN

Acute pain (moderate-to-severe):

IM, SubQ: The use of IM/ SubQ injections is no longer recommended especially for repeated administration due to painful administration, variable absorption and lag time to peak effect.

IV/IO: (Slow)

- **5mg (0.1 mg/kg, range 2.5 – 10mg)** every 1-6 hours PRN

PEDIATRIC Always Reference BROSELOW Tape

Acute pain (moderate-to-severe):

IM, SubQ: The use of IM/ SubQ injections is no longer recommended especially for repeated administration due to painful administration, variable absorption and lag time to peak effect.

IV: (Slow)

- **0.1-0.2 mg/kg** q 2-4 hr PRN, not to exceed 10 mg per dose

Continuous infusion:

- **10-30 mcg/kg/hour**; titrate PRN for pain

MOXIFLOXACIN ♀C, Lactation Yes Trade Name Avelox

Class / Mechanism of Action

Antibiotic (Fluoroquinolone)
Bactericidal - DNA gyrase inhibitor and topoisomerase IV inhibitor – which is an essential enzyme that maintains the superhelical structure, replication, transcription, and repair of bacterial DNA.

Indications

Labeled Indications: Used for infection control prophylaxis for traumatic open injuries and surgical prophylaxis.

Contraindications

- Hypersensitivity to cefazolin, other cephalosporin antibiotics, other beta-lactams, or any component of the formulation
- May cause QT prolongation.
- Avoid use in known aortic aneurysm or dissection

Adverse Reactions / Precautions

- Superinfection – prolonged use may result in fungal or bacterial superinfection (including C.Difficile)

Dose and Administration: ADULT	PEDIATRIC

Infection Control:
For PO tolerable patients
 	
PO:
Adults:
• 400 mg once daily
  ○ Max daily dose: 400 mg/day
	Infection Control:
	
	PO:
	Pediatrics:
	
	<15yrs old:
	• 10 mg/kg/day PO
	  ○ Max daily dose: 400 mg/day
	
	>15yrs old:
	• 400 mg once daily
	  ○ Max daily dose: 400 mg/day

NALOXONE

♀C, **Lactation ?**(Caution)

Trade Name: **Narcan**

Class / Mechanism of Action

Antidote, Opioid Antagonist

Competes and displaces opioids at opioid receptor sites, reversing narcotic effects.

Indications

Labeled Indications: Reversal of opioid drug effects, including respiratory depression

Contraindications

- Hypersensitivity to naloxone or any component of the formulation

Adverse Reactions / Precautions

- When correcting for respiratory depression in a postoperative (intubated patient), carefully titrate the dose to reverse hypoventilation; do not fully awaken patient or reverse analgesic effect.
- Recurrence of respiratory depression is possible continue to watch for respiratory depression until patient hand-off.
- May cause narcotic withdrawal effects

Dose and Administration:

ADULT

Opioid overdose (with standard ACS protocols):

IV, IM, SubQ:

- **0.4-2 mg**; may dose every 2-3 minutes if needed;
  - If no response after 10 mg total, look for other cause of respiratory depression.
  - Following reversal, may need to readminister after 20-60 minutes.

Reversal of respiratory depression with therapeutic opioid doses:

IV, IM, SubQ:

- **0.1-0.4 mg** titrated to adequate respiratory rate. If not improved after 0.8 mg total, look for other cause of respiratory depression.

PEDIATRIC Always Reference BROSELOW Tape

Opioid overdose (with standard PALS protocols):

IV, IM, SubQ:

- <5 years or ≤20 kg (unlabeled dose): **0.1 mg/kg/dose** (maximum dose: 2 mg); repeat every 2-3 minutes PRN
- ≥5 years or >20 kg: Adult Dosing

Reversal of respiratory depression with therapeutic opioid doses:

IV, IM, SubQ:

- **0.001-0.015 mg/kg/dose**; repeat as needed.

NIFEDIPINE

♀C, **Lactation Yes**(Not Recommended) Trade Name: **Procardia**

Class / Mechanism of Action

Antianginal Agent, Calcium Channel Blocker

Inhibits movement of calcium ion across cell membranes of smooth muscle and myocardium resulting in relaxation of coronary vascular smooth muscle and vasodilation as well as reduced peripheral vascular resistance (reducing blood pressure).

Indications

Labeled Indications: Chronic stable or vasospastic angina

Unlabeled: Prevention and treatment of high altitude pulmonary edema

Contraindications

- Hypersensitivity to nifedipine or any component of the formulation
- Cardiogenic Shock
- Acute MI

Adverse Reactions / Precautions

- Symptomatic hypotension:
- Bradycardia, nausea

Dose and Administration:	**ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
	High altitude pulmonary edema (unlabeled use): PO: • **10 mg** every 4-6 hours **Pulmonary hypertension** (unlabeled use) PO: • **30 mg** (Extended Release) twice daily; may increase cautiously to 120-240 mg/day **Note:** Do not use for acute anginal episodes; may precipitate myocardial infarction	**High altitude pulmonary edema** (Not FDA approved for use in children) (unlabeled use): PO: • Immediate release: **0.5 mg/kg/dose** (maximum: 20 mg/dose) every 8 hours **Note:** Treatment is needed only necessary if response to oxygen and/or descent is poor.

NITROGLYCERIN

♀C, **Lactation ?**(Caution) Trade Name: **NitroMist/Nitrostat**

Class / Mechanism of Action

Antianginal agent, Vasodialator

Induces smooth muscle relaxation and vasodilation of peripheral veins and arteries and coronary arteries thus improving collateral blood flow to ischemic regions of the myocardium. Reduces cardiac oxygen demand by decreasing preload. Onset of action: Sublingual tablet and spray, 1-3 minutes. Duration: 25 minutes

Indications

Labeled Indications: Treatment or prevention of angina pectoris

Contraindications

- Hypersensitivity to nitrates or any component of the formulation
- Use with phosphodiesterase-5 inhibitors (Sildenafil, Levitra, Cialis) in previous 48hrs
- Increased intracranial pressure
- Hypotension (SBP <90mmHg or >30mmHg below baseline), Bradycardia <50bpm, Tachycardia without heart failure (>100bpm), and Right ventricular infarction.

Adverse Reactions / Precautions

- **IV/IO access should be placed and SBP should be > 110.**
  - **Use cautiously in cases of chest pain unless inferior wall / right-ventricular MI can be ruled-out by ECG prior to administration**
- Can cause severe hypotension with associated paradoxical bradycardia and increased angina
- Use with caution in volume depleted patients
- Do not use for inferior wall MI and suspected right ventricular involvement

Dose and Administration:

ADULT

Angina/coronary artery disease:

PO:

- Sublingual: **0.4 mg** every 5 minutes for maximum of 3 doses in 15 minutes
- Translingual: **1 spray** (0.4mg per spray) onto or under tongue every 3-5 minutes for maximum of 3 doses in 15 minutes

CHF related Respiratory Distress:

PO:

- Sublingual: **0.4 mg** every 5 minutes for maximum of 3 doses in 15 minutes as long as SBP>90

IV Drip: (Only used at written direction of referring provider or consultation with medical director)

- Start at **10 mcg/min**, titrate up or down to:
  - 10% reduction in MAP if normotensive
  - 30% reduction in MAP if hypertensive.
  - Max dose: 400mcg/minute)

PEDIATRIC Always Reference BROSELOW Tape

Not indicated in most children, even with heart failure, as their heart failure is not usually due to coronary artery disease. Could cause significant problems in those with depressed myocardial function. Consult Medical Direction (if able) before use in Pediatrics.

CHF related Respiratory Distress:

PO:

- **0.4mg** q 5min if SBP > 70 + 2 x Age

CHF or Cardiogenic Shock:

IV Drip:

- Children: **0.25 - 0.5 mcg/kg/min**; titrate by 1 mcg/kg/min q 15-20 min as tolerated (Typical dose=1-5mcg/kg/min)(Max 10mcg/kg/min)
- Adolescents: **5-10 mcg/min** (not per kg) (max 200 mcg/min)

NOREPINEPHRINE

♀C, **Lactation? (**Caution)

Trade Name: **Levophed**

Class / Mechanism of Action

Alpha and Beta Agonist

Stimulates beta$_1$ and alpha adrenergic receptors: increases contractility, heart rate, and vasoconstriction. Increases systemic blood pressure and coronary blood flow. Effects on vasoconstriction (alpha receptors) are greater than inotropic (beta receptors). Onset of action: IV very rapid. Duration: 1-2 minutes

Indications

Labeled Indications: Treatment of shock persisting after adequate fluid volume replacement; severe hypotension.

ALS 2020: Severe cardiogenic shock and hemodynamically significant hypotension (SBP <70mmHg) with low total peripheral resistance. Agent of last resort for management of ischemic heart disease and shock.

Contraindications

- Hypersensitivity to norepinephrine, bisulfites or any component of the formulation
- Hypotension from hypovolemia except as an emergency measure to maintain coronary and cerebral perfusion until volume can be replaced

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Strong Vesicant; ensure proper catheter placement and avoid extravasation, use a large vein (preferably a central line) and avoid leg veins.
- Assure adequate circulatory volume to minimize need for vasoconstrictors. Monitor BP closely, avoid hypertension and adjust infusion rate as needed.

Dose and Administration:

ADULT

Hypotension/shock:

IV: Administer as continuous infusion with infusion pump. Do not use in same line as sodium bicarbonate. It will inactivate norepinephrine.

- Initial: **2-20 mcg/minute**; titrate to SBP goal.
  - Maintenance: **2-4 mcg/minute**

Post ROSC Hypotension:

- Initial: **0.1-0.5 mcg/kg/minute** titrate to effect.

If unable to maintain MAP >60mmHg, add **Epinephrine** infusion.

Use in Burn Patient:

For Burn patients, norepinephrine is only used when target MAP (≥55) and UOP (≥30mL/hr) fail to be reached with fluid resuscitation alone. Its sequence of use follows administration of **Vasopressin.**

(See infusion chart next page for mix and dosage information)

PEDIATRIC

Hypotension/shock:

IV: Continuous infusion

- Initial: **0.05-0.1 mcg/kg/minute**; titrate to effect
  - Max dose: 2 mcg/kg/minute

NOREPINEPHRINE (LEVOPHED)					
Dosing Range: 2-20mcg/min (120-1200mcg/hr)					
MIX 4 mg/500 mL CONCENTRATION 8 mcg/mL					
Dose	Rate	Micro (60 gtt/mL)	Macro		
			20 gtt/mL	15 gtt/mL	10 gtt/mL
mcg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
2	15	15	5	4	3
3	23	23	8	6	4
4	30	30	10	8	5
5	38	38	13	10	6
6	45	45	15	11	8
7	53	53	18	13	9
8	60	60	20	15	10
9	68	68	23	17	11
10	75	75	25	19	13
11	83	83	28	21	14
12	90	90	30	23	15
13	98	98	33	25	16
14	105	105	35	26	18
15	113	113	38	28	19
16	120	120	40	30	20
17	128	128	43	32	21
18	135	135	45	34	23
19	143	143	48	36	24
20	150	150	50	38	25
Macro-Drip (20gtt/ml) or Micro-Drip is set of choice for this infusion					
Start at lowest dose and increase rate by 0.5mcg/min every 2 minutes PRN to target MAP >60mmHg					

ONDANSETRON

♀B, **Lactation?**(Caution) Trade Name: **Zofran**

Class / Mechanism of Action

Antiemetic
Blocks serotonin, peripherally on vagus nerve terminals and centrally. Onset of action is 5-30 minutes dependent on route.

Indications

Labeled Indications: Prevention of postoperative nausea and vomiting
Unlabeled: Hyperemesis gravidarum (severe or refractory)

Contraindications

- Hypersensitivity to ondansetron or any component of the formulation

Adverse Reactions / Precautions

- Dose dependent QT interval prolongation occurs and IV doses >16mg are not recommended.
  - In most patients, QT changes are not clinically relevant; however, if used with other medications that prolong QT intervals (antiarrhythmics) or in those at risk for QT prolongation, arrhythmia can occur. Torsades de points has been reported.

Dose and Administration:

ADULT

Nausea and Vomiting:
IV/IO/IM/PO

- **4-8 mg**

Treatment of severe or refractory hyperemesis gravidum (unlabeled use):
IV:

- **8 mg** administered over 15 minutes every 12 hours

PEDIATRIC Always Reference BROSELOW Tape

Nausea and Vomiting (Children 1 month to 12 years):
IV:

- ≤40 kg**: 0.1 mg/kg** as a single dose over 2-5 minutes
- >40 kg**: 4 mg** as a single dose over 2-5 Minutes

PHENYLEPHRINE ♀C, Lactation?(Caution) Trade Name: **Neosynephrine**

Class / Mechanism of Action

Alpha Adrenergic Agonist

Potent, direct acting alpha adrenergic agonist with virtually no beta adrenergic activity; causes systemic arterial vasoconstriction.

Onset of action IV: Immediate, Duration: approximately 15-20 minutes.

Indications

Labeled Indications: Treatment of hypotension, vascular failure in shock

Contraindications

- Hypersensitivity to phenylephrine or any component of the formulation
- Ventricular Tachycardia and Hypertension
- Bradycardia

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Not recommended for routine use in the treatment of septic shock
- Reflexive Bradycardia. Assure adequate circulatory volume to minimize need for vasoconstrictors. Monitor BP closely, avoid hypertension and adjust infusion rate as needed.
- Vesicant: Avoid extravasation, will cause tissue damage/necrosis, ensure proper needle placement

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Hypotension / Shock:

IV Push:

- **50-200 mcg/dose** q 5-10 minutes
  - Max 1000 mcg
  - Titrate to blood pressure, use as temporary support or bridge to Vasopressor drip
  - Mix 10mg phenylephrine in 100mL NS for a concentration of 100mcg/mL

IV Infusion:

- **40 - 200 mcg/min;** titrate to MAP > 60 mm Hg.
  - To titrate, increase rate by 10 mcg/min every 2 minutes.
  - Maximum dose is 200 mcg/min.
  - Mix 10mg phenylephrine in 250mL D5W/NS for a concentration for 40mcg/mL

If unable to maintain MAP >60mmHg, add Epinephrine infusion.

Hypotension / Shock:

IV Push:

- **5-20 mcg/kg/dose** every 10-15 minutes as needed

IV Infusion:

- **0.1-0.5 mcg/kg/minute**

Note: Almost never used in pediatric shock. Isolated increased afterload usually causes significant problems in this population. Use with caution and contact Medical Direction if able.

PRALIDOXIME CHLORIDE

♀C, **Lactation?**(Caution) Trade: **2-Pam Chloride**

Class / Mechanism of Action

Antidote for organophosphate anticholinesterase poisoning
Peak plasma concentration following IM dose is reached in approximately 30 minutes

Indications

Labeled Indications:

- Organophosphate Pesticide Poisoning: Used with Atropine to reverse muscle paralysis
- Chemical Warfare Agent Poisoning: Used with Atropine for treatment of nerve agent (e.g., sarin, soman, tabun, VX [methylphosphonothioic acid])

Contraindications

- None in emergency setting

Adverse Reactions / Precautions

- Not effective in exposure to phosphorus, inorganic phosphates, or organophosphates that do not possess anticholinesterase activity.
- Consider cautions and adverse reactions of Atropine when using together
- Monitor BP and cardiac rhythm

Dose and Administration:

Pesticide Poisoning:

Mild symptoms: Miosis or blurred vision, tearing, runny nose, hypersalivation or drooling, wheezing, muscle fasciculations, nausea/vomiting.
Severe symptoms: behavioral changes, severe breathing difficulty, severe respiratory secretions, severe muscle twitching, involuntary defecation or urination, seizures, unconsciousness.

Chemical Warfare Agent Poisoning:

Mild to moderate symptoms: localized sweating, muscle fasciculations, nausea, vomiting, weakness, and/or dyspnea.
Severe symptoms: apnea, flaccid paralysis, seizures, and/or unconsciousness.

DOSING:

Auto-injector: IM into anterolateral aspect of thigh and hold in place for 10 seconds.

- Pralidoxime chloride auto-injector single dose 600mg: (administer after **Atropine**). Repeat injections if symptoms remain after 15min. Repeat again if not resolved after 2nd 15min.
- DuoDote®, ATNAA: For ≥2 mild symptoms, inject single dose. If severe symptoms develop, inject 2 additional doses in rapid succession.
- DuoDote®, ATNAA: For severe symptoms, utilize 3 auto-injectors (total dose: atropine 6.3 mg and pralidoxime chloride 1800 mg) in rapid succession.

Note: DuoDote® and ATNAA auto-syringe provides a sequential single IM dose of atropine (2.1mg) and pralidoxime chloride (600mg) through one needle.

Chemical Warfare Agent Poisoning:

Pralidoxime (2-PAM) Drip Protocol 8-10mg/kg/hr
*given after 1800mg IM Injection (3 ATNAAs) if symptoms persist.

1. Reconstitute 1 gram 2-PAM with 20mL of sterile water
2. Add 10mL 2Pam (500mg) to 100 mL Bag of NS and infuse over 5 minutes
3. Prepare continuous infusion by mixing 1 gram (20mL reconstituted) in 100mL bag of NS which will provide a 10mg/mL solution. Can also prepare 10 grams in 1L NS for a 10mg/mL solution.
4. Begin continuous infusion at 10mg/kg/hr.

Chemical Warfare Agent Poisoning: Organophosphate Anticholinesterase Nerve Agents:

IM:

- Children 0–10 years of age and adolescents >10 years of age who present with mild/moderate symptoms: 15 mg/kg.
- Children 0–10 years of age and adolescents >10 years of age who present with severe symptoms: 25 mg/kg.
- Children and Adolescents ≥40 kg dose as adult

PROCAINAMIDE

♀C, **Lactation?**(Not Recommended) Trade Name: **Procanbid**

Class / Mechanism of Action

Antiarrhythmic Agent, Class Ia

Decreases myocardial excitability & conduction velocity, may depress myocardial contractility by increasing the electrical stimulation threshold of ventricle, His-Purkinje system and through direct cardiac effects

Onset of action: IV: 5 minutes, IM: (**Not for emergent situations)** 10 to 30 minutes, Duration 4-6 hours

Indications

Labeled Indications: Treatment of supraventricular arrhythmias, life-threatening ventricular arrhythmias.

Unlabeled: Atrial fibrillation (preexcited); Junctional tachycardia; Stable monomorphic ventricular tachycardia.

Contraindications

- Hypersensitivity to procainamide, procaine, other ester-type local anesthetics
- complete heart block; second-degree AV block or various types of hemiblock
- SLE (Systemic lupus erythematosus)
- Torsade de pointes

Adverse Reactions / Precautions

- Lupus-like syndrome
- Hypotension
- Skin rash
- Diarrhea, dysgeusia, nausea/vomiting

Dose and Administration:

ADULT

Ventricular arrhythmias/ Atrial fibrillation (preexcited):

Note: Dose must be individualized and titrated to patient response

- IV Loading dose: 10 to 17 mg/kg at a rate of 20 to 50 mg/minute **or** 100 mg every 5 minutes;
- Must dilute prior to IV administration. Dilute loading dose to a maximum concentration of 20 mg/mL; administer loading dose at a maximum rate of 50 mg/minute until:
  - Arrhythmia suppression
  - Hypotension
  - QRS widens by >50%
  - total dose 17mg/kg reached
- Maintenance infusion: 2 to 6 mg/min

PEDIATRIC Always Reference BROSELOW Tape

Ventricular arrhythmias:

Infants, Children, and Adolescents IV:

- Loading dose: 10 to 15 mg/kg over 30 to 60 minutes
  - Neonates: Administer over 60 minutes
  - Infants and Children: Administer over 30 to 60 minutes
  - Adolescents: Administer at usual infusion rate: 20 to 50 mg/minute not to exceed 50 mg/minute
- Maintenance infusion: 20 to 80 **mcg**/kg/minute; maximum daily dose: 2000 mg/24 hours

Note: Infusion rate should be decreased if QT interval becomes prolonged or patient develops heart block; discontinue the infusion if patient develops hypotension or QRS interval widens to >50% of baseline; severe hypotension can occur with rapid IV administration

PROMETHAZINE

♀C, **Lactation?**(Not Recommended) Trade Name: **Phenergan**

Class / Mechanism of Action

Phenothiazine derivative Antiemetic, Histamine H_1 Antagonist, Sedative

Blocks postsynaptic dopaminergic receptors in the brain; strong alpha adrenergic blocking effect and depresses release of hypothalamic and hypophyseal hormones; reduces stimuli to the reticular system

Onset of action IV: 5 minutes, Duration 4-6 hours

Indications

Labeled Indications: Symptomatic treatment for allergic conditions; antiemetic; motion sickness; sedative; adjunct to postoperative analgesia and anesthesia

Unlabeled: Treatment of nausea and vomiting of pregnancy

Contraindications

- Hypersensitivity to promethazine, phenothiazine allergy, or any component of the formulation
- Coma
- Children <2 years old
- Intra-arterial and SubQ administration

Adverse Reactions / Precautions

- May cause Bradycardia, hyper-/hypotension, nonspecific QT changes, orthostatic hypotension, tachycardia: Life threatening arrhythmias have occurred with normal dosage
- May cause extrapyramidal symptoms (pseudoparkinsonism, acute dystonic reactions, akathisia, etc.)
- Avoid use in severe respiratory disease (asthma, COPD), and in patients using other sedatives or depressants: may lead to respiratory depression
- **Vesicant**: can cause severe tissue injury regardless of route of delivery
  - Deep IM injection; or IV in line. Slow IVP over 1 minute
  - For IV, ensure proper needle/catheter venous placement; avoid extravasation

Dose and Administration: ADULT

Antiemetic:

IV push over >1 minute

- **12.5 mg, not to exceed 25 mg**
  - May repeat 12.5mg once after 10 minutes if first dose ineffective
  - Subsequent dose of 25mg may be given every 4 hours
  - Can dilute with 10-20mL of NS

Sedation, analgesia/hypnotic adjunct:

IM, IV:

- **25-50 mg** in combination with analgesic or hypnotic (at reduced dosage)

Allergic conditions (including allergic reactions to blood or plasma):

IM, IV:

- **25 mg**, may repeat in 2 hours when necessary

PEDIATRIC Always Reference BROSELOW Tape

Antiemetic:

IM, IV:

- Children ≥2 years: **0.25 mg/kg** 4-6 times/day as needed (maximum: 12.5 mg/dose)

Preoperative analgesia/hypnotic adjunct:

IM, IV:

- Children ≥2 years: **1.1 mg/kg** in combination with an analgesic or hypnotic (at reduced dosage) and with an atropine like agent (at appropriate dosage).

Note: Promethazine dosage should not exceed half of suggested adult dosage.

PROPOFOL

♀B, **Lactation Yes**(Not Recommended) Trade Name: **Diprivan**

Class / Mechanism of Action

General Anesthetic

Lipophilic intravenous general anesthetic.

Onset of action IV bolus: 9-51 seconds (average 30 seconds), Duration is dose and rate dependent: 3-10 minutes, prolonged with continued doses

Indications

Labeled Indications: Induction of anesthesia in patients ≥3 years of age; maintenance of anesthesia in patients >2 months of age; sedation in intubated, mechanically-ventilated ICU patients

Contraindications

- Hypersensitivity to propofol or any component of the formulation
- Allergy to eggs, egg products, soybeans, soy products, and peanuts.

Adverse Reactions / Precautions

- May cause Hypotension especially in hypovolemic patients or if bolus dosing is used.
  - Hypotension may result in reduction of MAP exceeding 30%
    - Head Injury patients or those with suspected / known increased intracranial pressure are at increased risk of decreased cerebral perfusion pressure.
- Do not use in pre-hospital trauma environment or in transfer patients unless directed by medical director or provided written orders by referring provider.
- No Analgesic properties. Must supplement with analgesic agents.

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

ADULT

Sedation/ RSI:

IV Push:

- **1-2.5 mg/kg** every 5-10min PRN.

Maintenance of general anesthesia:

IV Infusion:

- **10-75 mcg/kg/min** via infusion pump or Dial-a-Drip. Titrate to minimum effective dose. **(See infusion chart next page)**
  - MAX DOSE: 100 mcg/kg/min.
- Use of Dial-a-Drip tubing in the absence of an infusion pump will increase accuracy of infusion dosage.

Note: Wait 3-5 minutes between dosage changes to clinically assess drug effects. Smaller doses are required when used with opioids.

PEDIATRIC

Sedation/ RSI:

IV Push:

- **1-2.5 mg/kg** every 5-10min PRN.

Maintenance of general anesthesia,

IV Infusion:

Healthy children 2 months to 16 years:

- **125-300 mcg/kg/minute** (or 7.5-18 mg/kg/hour)

PROPOFOL (DIPRIVAN)						
Dosing Range: 10-75mcg/kg/min (600-3000mcg/kg/hr)						
MIX 500 mg/50 mL CONCENTRATION 10 mg/mL						
Pt. Weight	Dose	Rate	Micro	Macro		
			(60 gtt/mL)	20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
50	10	3	3	1	1	1
	15	5	5	2	1	1
	20	6	6	2	2	1
	25	8	8	3	2	1
	30	9	9	3	2	2
	35	11	11	4	3	2
	40	12	12	4	3	2
	45	14	14	5	3	2
	50	15	15	5	4	3
	55	17	17	6	4	3
	60	18	18	6	5	3
	65	20	20	7	5	3
	70	21	21	7	5	4
	75	23	23	8	6	4
55	10	3	3	1	1	1
	15	5	5	2	1	1
	20	7	7	2	2	1
	25	8	8	3	2	1
	30	10	10	3	2	2
	35	12	12	4	3	2
	40	13	13	4	3	2
	45	15	15	5	4	2
	50	17	17	6	4	3
	55	18	18	6	5	3
	60	20	20	7	5	3
	65	21	21	7	5	4
	70	23	23	8	6	4
	75	25	25	8	6	4
60	10	4	4	1	1	1
	15	5	5	2	1	1
	20	7	7	2	2	1
	25	9	9	3	2	2
	30	11	11	4	3	2
	35	13	13	4	3	2
	40	14	14	5	4	2
	45	16	16	5	4	3
	50	18	18	6	5	3
	55	20	20	7	5	3
	60	22	22	7	5	4
	65	23	23	8	6	4
	70	25	25	8	6	4
	75	27	27	9	7	5
65	10	4	4	1	1	1
	15	6	6	2	1	1
	20	8	8	3	2	1
	25	10	10	3	2	2
	30	12	12	4	3	2
	35	14	14	5	3	2
	40	16	16	5	4	3
	45	18	18	6	4	3
	50	20	20	7	5	3
	55	21	21	7	5	4
	60	23	23	8	6	4
	65	25	25	8	6	4
	70	27	27	9	7	5
	75	29	29	10	7	5
70	10	4	4	1	1	1
	15	6	6	2	2	1
	20	8	8	3	2	1
	25	11	11	4	3	2
	30	13	13	4	3	2
	35	15	15	5	4	2
	40	17	17	6	4	3
	45	19	19	6	5	3
	50	21	21	7	5	4
	55	23	23	8	6	4
	60	25	25	8	6	4
	65	27	27	9	7	5
	70	29	29	10	7	5
	75	32	32	11	8	5
75	10	5	5	2	1	1
	15	7	7	2	2	1
	20	9	9	3	2	2
	25	11	11	4	3	2
	30	14	14	5	3	2
	35	16	16	5	4	3
	40	18	18	6	5	3
	45	20	20	7	5	3
	50	23	23	8	6	4
	55	25	25	8	6	4
	60	27	27	9	7	5
	65	29	29	10	7	5
	70	32	32	11	8	5
	75	34	34	11	8	6
Macro-Drip (20gtt/ml) or Micro-Drip is set of choice for this infusion						
Titrate to minimum effective dose. Allow 3-5 minutes between dosing changes to sedative and hemodynamic effects.						

PROPOFOL (DIPRIVAN)						
Dosing Range: 10-75mcg/kg/min (600-3000mcg/kg/hr)						
MIX 500 mg/50 mL CONCENTRATION 10 mg/mL						
Pt. Weight	Dose	Rate	Micro	Macro		
			(60 gtt/mL)	20 gtt/mL	15 gtt/mL	10 gtt/mL
kg	mcg/kg/min	mL/hr	gtt/min	gtt/min	gtt/min	gtt/min
80	10	5	5	2	1	1
	15	7	7	2	2	1
	20	10	10	3	2	2
	25	12	12	4	3	2
	30	14	14	5	4	2
	35	17	17	6	4	3
	40	19	19	6	5	3
	45	22	22	7	5	4
	50	24	24	8	6	4
	55	26	26	9	7	4
	60	29	29	10	7	5
	65	31	31	10	8	5
	70	34	34	11	8	6
	75	36	36	12	9	6
85	10	5	5	2	1	1
	15	8	8	3	2	1
	20	10	10	3	3	2
	25	13	13	4	3	2
	30	15	15	5	4	3
	35	18	18	6	4	3
	40	20	20	7	5	3
	45	23	23	8	6	4
	50	26	26	9	6	4
	55	28	28	9	7	5
	60	31	31	10	8	5
	65	33	33	11	8	6
	70	36	36	12	9	6
	75	38	38	13	10	6
90	10	5	5	2	1	1
	15	8	8	3	2	1
	20	11	11	4	3	2
	25	14	14	5	3	2
	30	16	16	5	4	3
	35	19	19	6	5	3
	40	22	22	7	5	4
	45	24	24	8	6	4
	50	27	27	9	7	5
	55	30	30	10	7	5
	60	32	32	11	8	5
	65	35	35	12	9	6
	70	38	38	13	9	6
	75	41	41	14	10	7
95	10	6	6	2	1	1
	15	9	9	3	2	1
	20	11	11	4	3	2
	25	14	14	5	4	2
	30	17	17	6	4	3
	35	20	20	7	5	3
	40	23	23	8	6	4
	45	26	26	9	6	4
	50	29	29	10	7	5
	55	31	31	10	8	5
	60	34	34	11	9	6
	65	37	37	12	9	6
	70	40	40	13	10	7
	75	43	43	14	11	7
100	10	6	6	2	2	1
	15	9	9	3	2	2
	20	12	12	4	3	2
	25	15	15	5	4	3
	30	18	18	6	5	3
	35	21	21	7	5	4
	40	24	24	8	6	4
	45	27	27	9	7	5
	50	30	30	10	8	5
	55	33	33	11	8	6
	60	36	36	12	9	6
	65	39	39	13	10	7
	70	42	42	14	11	7
	75	45	45	15	11	8
105	10	6	6	2	2	1
	15	9	9	3	2	2
	20	13	13	4	3	2
	25	16	16	5	4	3
	30	19	19	6	5	3
	35	22	22	7	6	4
	40	25	25	8	6	4
	45	28	28	9	7	5
	50	32	32	11	8	5
	55	35	35	12	9	6
	60	38	38	13	9	6
	65	41	41	14	10	7
	70	44	44	15	11	7
	75	47	47	16	12	8
Macro-Drip (20gtt/ml) or Micro-Drip is set of choice for this infusion						
Titrate to minimum effective dose. Allow 3-5 minutes between dosing changes to sedative and hemodynamic effects.						

ROCURONIUM

♀C, **Lactation?**(Caution)

Trade Name: **Zemuron**

Class / Mechanism of Action

Nondepolarizing Neuromuscular Blocking Agent (Paralytic)
Blocks acetylcholine from binding to motor neuron receptors inhibiting depolarization.
Onset of action IV: 1-2 minutes, Duration: approximately 25-40 minutes (increases with higher doses)

Indications

Labeled Indications: Rapid Sequence Intubation/Paralysis and routine endotracheal intubation, facilitates mechanical ventilation in ICU patients

Contraindications

- Hypersensitivity (eg, anaphylaxis) to rocuronium, other neuromuscular-blocking agents, or any component of the formulation

Adverse Reactions / Precautions

- Resistance may occur in burn patients (>30% of body) for period of 5-70 days after injury
- High potential for interactions: Numerous drugs either antagonize (eg, acetylcholinesterase inhibitors) or potentiate (eg, calcium channel blockers, certain antimicrobials, inhalation anesthetics, lithium, magnesium salts, procainamide, and quinidine) the effects of neuromuscular blockade; use with caution in patients receiving these agents.
- **Provides NO analgesia or sedation!**
    - **Must provide appropriate sedation and analgesia prior to paralytic use and throughout maintenance.**

Dose and Administration:

ADULT

RSI:
IV Push:

- **1mg/kg**
  (Dosing ranges from **0.6-1.2 mg/kg**)

Note: In adult patients with morbid obesity (BMI >40 kg/m2), use dose of 1.2 mg/kg using ideal body weight (IBW)

Maintenance dosing: (unlabeled and unreferenced dose)
IV Push:

- **1 mg/kg IV/IO q30-45min** PRN or 8-12 mcg/kg/min IV/IO
  (Dosing ranges from **0.6-1.2 mg/kg**)

PEDIATRIC Always Reference BROSELOW Tape

RSI:
IV:

- **1mg/kg**
  (Dosing ranges from **0.6 - 1.2 mg/kg**.)

Maintenance bolus dosing: (unlabeled and unreferenced dose)
IV Push:

- **1 mg/kg every 30-45 minutes**

(Dosing ranges from **0.6 - 1.2 mg/kg**.)

SODIUM BICARBONATE ♀C, Lactation Yes

Class / Mechanism of Action

Alkalinizing Agent; Antacid
Provides bicarbonate ion to neutralize hydrogen ion concentration and raise blood and urinary pH
Onset of action IV: 15 minutes, Duration 1-2 hours

Indications

Labeled Indications: Management of metabolic acidosis, hyperkalemia, overdose of certain drugs (including tricyclic antidepressants and aspirin), and gastric hyperacidity.

Contraindications

- Alkalosis, hypernatremia, hypocalcemia
- severe pulmonary edema
- Unknown abdominal pain

Adverse Reactions / Precautions

- Use should be reserved for documented metabolic acidosis and for hyperkalemia induced cardiac arrest. Routine use in cardiac arrest is not recommended.
- Avoid extravasation, tissue necrosis can occur.
- Can cause Hypernatremia, hypocalcemia, hypokalemia, intracranial acidosis, metabolic alkalosis

Dose and Administration: ADULT	PEDIATRIC Always Reference BROSELOW Tape
TriCyclic Antidepressant OD IV: • **1mEq/kg**; May repeat to maintain QRS <100 • Start Maintenance Infusion: **100-150mEq** (2-3 amps) in 1 L D5 / NS @ 100-200 mL/hr IV **Cardiac arrest (ACLS Guidelines, 2015):** IV: • **1 mEq/kg/dose**; repeat doses should be guided by arterial blood gases **Note:** Routine use in cardiac arrest is not recommended. Use may be considered in cases of prolonged cardiac arrest once adequate alveolar ventilation and effective cardiac compressions have been established. In some cardiac arrest situations (eg, metabolic acidosis, hyperkalemia, or tricyclic antidepressant overdose), sodium bicarbonate may be beneficial. **Hyperkalemia (ACLS Guidelines, 2015)** IV: • **50 mEq** over 5 minutes **Metabolic acidosis:** If acid-base status is not available: **2-5 mEq/kg** infusion over 4-8 hours	• **Follow Adult Dosing**

SUCCINYLCHOLINE

♀C, **Lactation?**(Caution)

Trade Name: **Anectine**

Class / Mechanism of Action

Depolarizing Neuromuscular Blocking Agent (Paralytic)

Acts like acetylcholine, produces myoneural depolarization causing sustained flaccid skeletal muscle paralysis. Onset of action IV: 30-60 seconds, Duration 5-9 minutes with single dose

Indications

Labeled Indications: Rapid Sequence Intubation and routine endotracheal intubation

Contraindications

- Hypersensitivity to succinylcholine or any component of the formulation
- Acute phase of injury following major burns, multiple trauma (greater than 5 days after injury)
- Myopathies associated with elevated serum creatine phosphokinase and myasthenia gravis
- **DO NOT USE IN PATIENTS WITH BURNS, CRUSH INJURIES, OR HYPERKALEMIA**
- Re-Dosing is not advised due to increased risk of Hyperkalemia
- Neuromuscular disease (Muscular dystrophy, Spinal Muscular Atrophy, etc.)

Adverse Reactions / Precautions

- May cause Bradycardia, Malignant hyperthermia, and increased intraocular pressure
- Severe hyperkalemia can develop in cases of chronic abdominal infection, burn injury, children with skeletal muscle myopathy, subarachnoid hemorrhage, or conditions which cause degeneration of the nervous system commonly greater than 5 days old. Potassium increase of 0.5 mEq/L is expected with use.
- **Provides NO analgesia or sedation!**
    - **Must provide appropriate sedation and analgesia prior to paralytic use and throughout maintenance.**

Dose and Administration:

ADULT

RSI/ Neuromuscular blockade:

IV:

- **1-1.5 mg/kg**

Note: Pretreatment with 10% dosage of non-depolarizing agents prior to neuromuscular-blockade with Succinylcholine is **NO LONGER ADVISED**

PEDIATRIC Always Reference BROSELOW Tape

RSII / Neuromuscular blockade:

IV:

- <10kg:
    - Initial: **1.5-2 mg/kg/dose**
- >10kg:
    - Initial: **1-1.5 mg/kg/dose**

Note: Pretreatment with 10% dosage of non-depolarizing agents prior to neuromuscular-blockade with Succinylcholine is **NO LONGER ADVISED**

THIAMINE	♀A, **LactationYes**(Caution)	Trade Name: **Vitamin B1**

Class / Mechanism of Action

Vitamin, water soluable
Essential coenzyme in carbohydrate metabolism. Onset of action IV/IM: Rapid

Indications

Labeled Indications: Treatment of thiamine deficiency including beriberi, Wernicke's encephalopathy, Korsakoff's syndrome, neuritis associated with pregnancy, or in alcoholic patients

Contraindications

- Hypersensitivity to thiamine or any component of the formulation

Adverse Reactions / Precautions

- Administration of dextrose may worsen acute symptoms of thiamine deficiency; use caution when low thiamine is suspect

Dose and Administration:	**ADULT**	**PEDIATRIC** Always Reference BROSELOW Tape
	<u>AMS; Seizure; Syncope; Malnutrition; Vomiting and Diarrhea; w/ Hx of ETOH abuse:</u> IM/IV: • **100mg/day**	**<u>AMS or Seizure w/ signs of Malnutrition:</u>** IM/IV: • **25mg/day**

TRANEXAMIC ACID

♀B, **Lactation: Yes**(Caution) Trade Name: **Cyklokapron/Lysteda**

Class / Mechanism of Action

Antifibrinolytic Agent, Hemostatic Agent

Displaces plasminogen from fibrin resulting in inhibition of fibrinolysis and inhibits the proteolytic activity of plasmin

Indications:

- Trauma-associated hemorrhage: Casualty likely needing blood transfusion (hemorrhagic shock, elevated lactate, one or more major amputations, penetrating torso trauma, or evidence of severe bleeding)
- Post-Operative Hemorrhage by dissection, enteric staples or suspected internal bleeding
- Signs or symptoms of significant TBI or altered mental status associated with blast or blunt trauma
- Postpartum Hemorrhage (continued bleeding despite Oxytocin and fundal massage)

Contraindications

- **TXA is contraindicated in trauma if dose is not given within first 3 hours following Traumatic event (Ideal dosing time-frame is within 1 hour of trauma)**
- Hypersensitivity to tranexamic
- Subarachnoid hemorrhage
- Thromboembolic disease (Cerebral Thrombosis, DVT, PE)

Adverse Reactions / Precautions

- Disseminated intravascular coagulation (DIC): Use with extreme caution in patients with DIC requiring antifibrinolytic therapy; patients should be under strict supervision of a physician experienced in treating this disorder. TXA should be used in Pt.'s with trauma related DIC however.
- Thrombosis (especially when given after 3hr from injury**)**
- Seizure

Dose and Administration:

ADULT

Trauma-associated hemorrhage (unlabeled use):

IV:

- Initial Dose: **2 gram of TXA** in 100 cc NS or LR ASAP via IV/IO Bolus, or 2 gram IV/IO push (1 gram over 1 minute per push) but **NOT** later than 3 hours after injury.
- If patient received **1 gram of TXA** prior and <3hrs from time of injury: **1 gram TXA** IV/IO push over 1 minute or mixed in 100cc NS or LR Bolus. If >3hr from time of injury: ***DO NOT*** administer TXA.

Suspected Post-Operative Hemorrhage by dissection, enteric staples or suspected internal bleeding:

- Initial Dose: **2 gram of TXA** in 100 cc NS or LR ASAP via IV/IO Bolus or 2 gram IV/IO push (1 gram over 1 minute push) but **NOT** later than 3 hours after start of suspected hemorrhage.

PEDIATRIC Always Reference BROSELOW Tape

Trauma-associated hemorrhage (unlabeled use):

IV:

- Initial Dose: **15mg/kg** via IV/IO Bolus (goal within 1 minute),

VASOPRESSIN

♀C, **Lactation?**(Caution)

Trade Name: **Vasostrict**

Class / Mechanism of Action

Antidiuretic Hormone Analog-Vasopressor

Vasopressin, at therapeutic doses used for vasodilatory shock, stimulates the AVPR1a (or V1) receptor and increases systemic vascular resistance and mean arterial blood pressure; in response to these effects, a decrease in heart rate and cardiac output may be seen.

Onset of action IV: Rapid with peak effect occurring within 15 minutes of initiation of continuous IV infusion. Duration: Within 20 minutes after IV infusion terminated.

Indications

Labeled Indications: Treatment of hypotension, vascular failure in shock

Contraindications

- Hypersensitivity to Vasopressin or any component of the formulation
- Use with caution in patients with asthma, cardiovascular disease, renal disease, or a history of seizure disorder

Adverse Reactions / Precautions

- **No applicable use in hemorrhagic shock unless fluid replacement therapy maximized! Maximize use of Blood products / Crystalloids before considering use in hemorrhagic shock.**
- Assure adequate circulatory volume to minimize need for vasoconstrictors. Monitor BP closely, avoid hypertension and adjust infusion rate as needed.
- Vesicant: Avoid extravasation, will cause tissue damage/necrosis, ensure proper needle placement
- Cardiac arrhythmias are possible, monitor with 12 lead EKG

Dose and Administration: **ADULT** **PEDIATRIC** Always Reference BROSELOW Tape

Hypotension / Shock:

Vasopressors should be used if patient is hypotensive after fluid resuscitation to maintain mean arterial pressure (MAP) ≥65 mmHg.

Use in addition to norepinephrine for raising MAP to target or to decrease norepinephrine dosage.

Titrate to lowest effective dose.

IV Infusion:
4 Unit bolus IV/IO followed by **0.04 U/min** infusion to maintain MAP>65 mmHg

Hypotension / Shock:

Limited data available; efficacy results have varied.

IV Infusion:

- **0.17 to 8 MILLIUNITS/kg/minute (0.01 to 0.48 units/kg/hour)**

VECURONIUM

♀C, **Lactation?**(Caution)

Trade Name: **Norcuron**

Class / Mechanism of Action

Nondepolarizing Neuromuscular Blocking Agent (Paralytic)
Blocks acetylcholine from binding to motor neuron receptors inhibiting depolarization.
Onset of action IV: 1.5-3 minutes, Duration: approximately 30-60 minutes

Indications

Labeled Indications: Endotracheal intubation, facilitates mechanical ventilation in ICU patients

Contraindications

- Hypersensitivity to vecuronium or any component of the formulation

Adverse Reactions / Precautions

- Resistance may occur in burn patients (>30% of body) for period of 5-70 days after injury
- High potential for interactions: Numerous drugs either antagonize (eg, acetylcholinesterase inhibitors) or potentiate (eg, calcium channel blockers, certain antimicrobials, inhalation anesthetics, lithium, magnesium salts, procainamide, and quinidine) the effects of neuromuscular blockade; use with caution in patients receiving these agents.
- **Provides NO analgesia or sedation!**
  - **Must provide appropriate sedation and analgesia prior to paralytic use and throughout maintenance.**

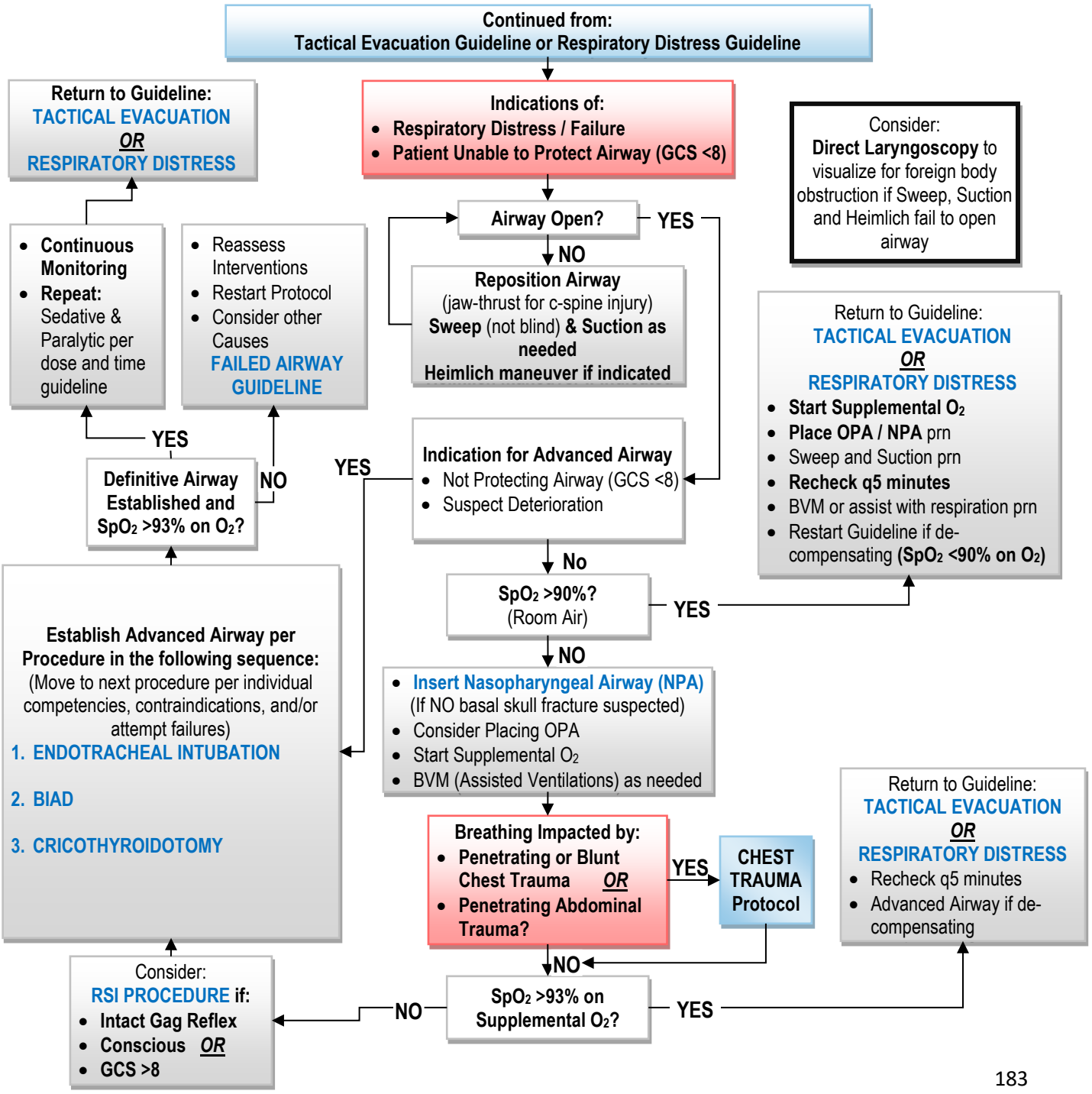
Dose and Administration:

ADULT	PEDIATRIC Always Reference BROSELOW Tape
RSI) and maintenance of paralysis: IV Push: • Induction: **0.1 mg/kg** **Dose range (0.8-0.15 mg/kg)** • Maintenance: **0.1 mg/kg** every 30-60 minutes PRN **Dose range (0.8-0.15 mg/kg)** IV Continuous infusion: • **1 mcg/kg/min** and titrate to 2:4 train of four (TOF) if stimulation devise is available. **Note:** Paralytic use and management: If available, utilize the train of four stimulation device with either the temple or radial/ulnar nerve placement. Maintain paralysis at a level of 2/4 twitches with TOF stimulation. **Note:** Vecuronium is only recommended for use in RSI in the absence of available Succinylcholine or Rocuronium, as they are the preferred induction agents.	**RSI and maintenance of paralysis::** IV Push: • Induction: **0.1-0.15 mg/kg** • Intermittent bolus dosing: **0.1 mg/kg** every 30-60 minutes PRN IV Continuous infusion: • **1-2.5 mcg/kg/minute**

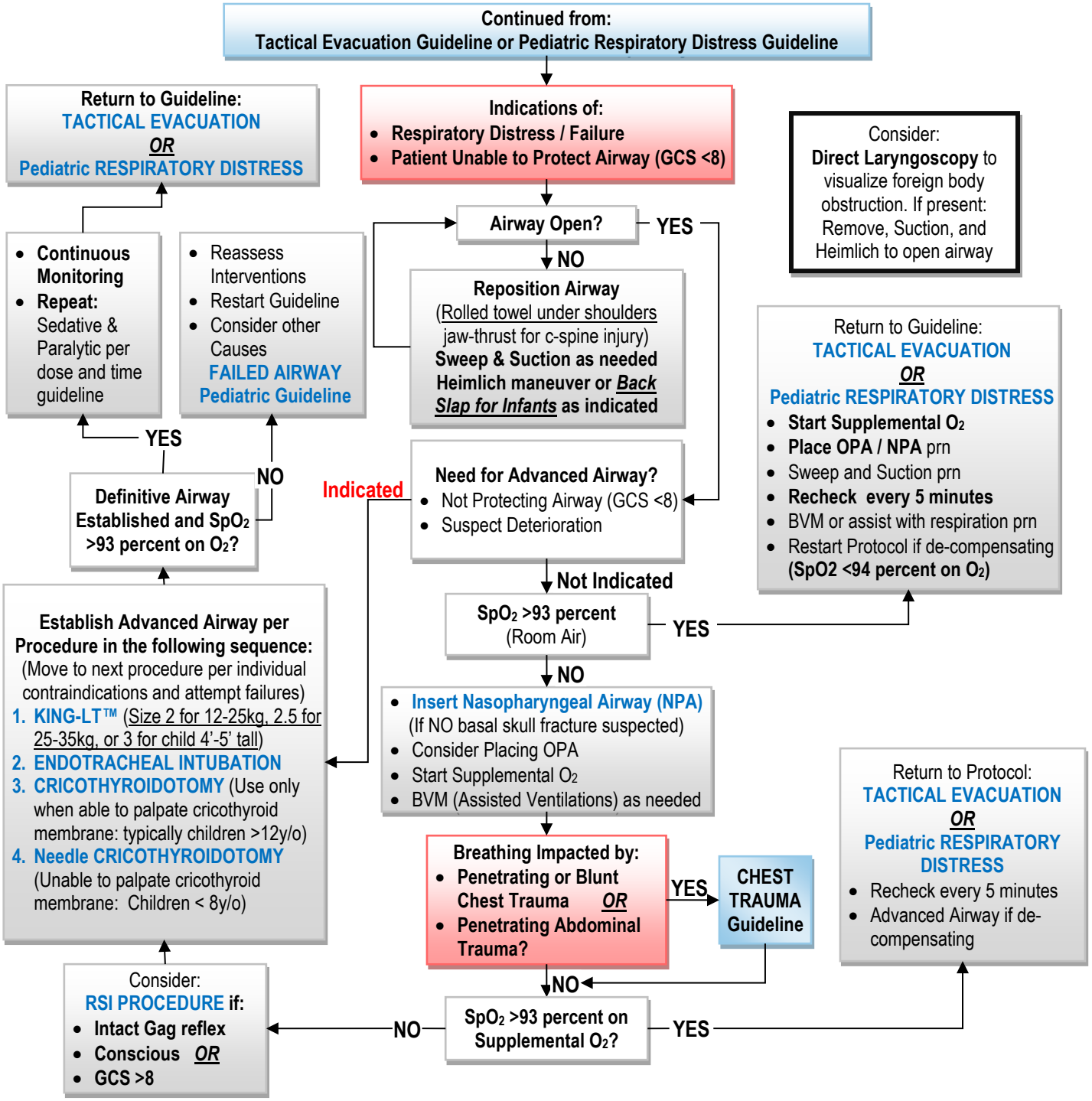
AIRWAY

Signs and Symptoms of Distress and/or Failure:

- **SpO_2 Decreasing or <90%** (Room Air) with / without supporting Signs / Symptoms of:
  - Tachypnea, Tachycardia, Fever, Cough, Wheezing, Rhonchi, Rales, Shock
- **Difficulty Breathing or Excess Work** as demonstrated by:
  - Pursing of Lips, Accessory Muscle Involvement, Cyanosis, Decreased Ability to Speak, Diaphoresis
- **Airway Obstruction** due to Trauma, Edema, Excess Secretions, Foreign Body, or Tongue
- **Apnea**
- **Decreased LOC** (GCS <8)



PEDIATRIC AIRWAY


Continued from:
Tactical Evacuation Guideline or Pediatric Respiratory Distress Guideline
Indications of:
• Respiratory Distress / Failure
• Patient Unable to Protect Airway (GCS <8)
Consider:
Direct Laryngoscopy to visualize foreign body obstruction. If present: Remove, Suction, and Heimlich to open airway
Airway Open?
YES
NO
Reposition Airway
(Rolled towel under shoulders jaw-thrust for c-spine injury)
Sweep & Suction as needed
Heimlich maneuver or Back Slap for Infants as indicated
Return to Guideline:
TACTICAL EVACUATION
OR
Pediatric RESPIRATORY DISTRESS
• Start Supplemental O2
• Place OPA / NPA prn
• Sweep and Suction prn
• Recheck every 5 minutes
• BVM or assist with respiration prn
• Restart Protocol if de-compensating
(SpO2 <94 percent on O2)
Need for Advanced Airway?
• Not Protecting Airway (GCS <8)
• Suspect Deterioration
Indicated
Not Indicated
SpO2 >93 percent
(Room Air)
YES
NO
• Insert Nasopharyngeal Airway (NPA)
(If NO basal skull fracture suspected)
• Consider Placing OPA
• Start Supplemental O2
• BVM (Assisted Ventilations) as needed
Breathing Impacted by:
• Penetrating or Blunt Chest Trauma OR
• Penetrating Abdominal Trauma?
YES
CHEST TRAUMA Guideline
NO
SpO2 >93 percent on Supplemental O2?
NO
YES
Return to Protocol:
TACTICAL EVACUATION
OR
Pediatric RESPIRATORY DISTRESS
• Recheck every 5 minutes
• Advanced Airway if de-compensating
Consider:
RSI PROCEDURE if:
• Intact Gag reflex
• Conscious OR
• GCS >8
Establish Advanced Airway per Procedure in the following sequence:
(Move to next procedure per individual contraindications and attempt failures)
1. KING-LT™ (Size 2 for 12-25kg, 2.5 for 25-35kg, or 3 for child 4'-5' tall)
2. ENDOTRACHEAL INTUBATION
3. CRICOTHYROIDOTOMY (Use only when able to palpate cricothyroid membrane: typically children >12y/o)
4. Needle CRICOTHYROIDOTOMY
(Unable to palpate cricothyroid membrane: Children < 8y/o)
Definitive Airway Established and SpO2 >93 percent on O2?
YES
NO
• Continuous Monitoring
• Repeat:
Sedative & Paralytic per dose and time guideline
• Reassess Interventions
• Restart Guideline
• Consider other Causes
FAILED AIRWAY
Pediatric Guideline
Return to Guideline:
TACTICAL EVACUATION
OR
Pediatric RESPIRATORY DISTRESS

AIRWAY Pearls

Signs and Symptoms of Respiratory Distress and/or Failure

- **SPO_2 decreasing <90%** (Room Air) with / without supporting Signs / Symptoms of:
  - Tachypnea, Tachycardia, Fever, Cough, Wheezing, Rhonchi, Rales, Shock
- **Difficulty Breathing or Excess Work** as demonstrated by:
  - Purpling of Lips, Accessory Muscle Involvement, Cyanosis, Decreased Ability to Speak, Diaphoresis, Tripod Breathing
- **Airway Obstruction** Due to Trauma, Edema, Excess Secretions, Foreign Body, or Tongue
- **Apnea**
- **Cyanosis,** Central and/or Peripheral: Blue/Pale Tinting and Mottling of Skin
- **Decreased LOC** (GCS <8), **Altered Responsiveness, Weak Cry**

Pearls:

- **PCO_2 is affected by respiratory rate and tidal volume (ventilation), while PO_2 is affected by PEEP and FiO_2 (oxygenation)**
- Capnography is mandatory for all intubations. Record results. Capnometer (standalone END TIDAL CO_2 detector) is an alternate if monitor capnography not available**. For capnography, normal range is 35-45 mm Hg;** adjust vent as needed.
- All intubated patients should receive nasogastric / orogastric tube (time permitting) and continuous pulse oximetry.
- **Maternal Medication:** Adverse effects can include respiratory insult to newborn.
- Pediatric is defined as anyone <12yo.
- **If RSI is impractical or provider is not credentialed to perform**, but patient requires an advanced airway with / without ventilatory support, consider:
  1. Pharmacologically-Assisted Sedation using KETAMINE followed by supraglottic airway device placement (do not attempt BIAD placement without sedation in semi-conscious patients)
  2. Surgical cricothyroidotomy using approved device. (modified 6.0 ET not ideal)
  3. Medical personnel should not actively seek to determine if gag reflex is present by touching the palate, posterior lounge, or posterior pharynx.

RSI MEDICATIONS: IV/IO Doses

Pretreatment:
Fentanyl 3mcg/kg IV
Atropine 0.02mg/kg IV Min: 0.1mg (**Infants <1yo)**

Induction Agents:	**80kg adult dose:**
Etomidate 0.3mg/kg	24mg
*Ketamine 1-2mg/kg	80-160mg
Midazolam 0.1mg/kg	8mg
Propofol 1-2.5 mg/kg	80-200mg

Paralytics:
Vecuronium 0.08-0.15 mg/kg
*Rocuronium 0.6-1.2 mg/kg, q25-40min
Succinylcholine 1.0-1.5mg/kg

Continued Sedation:
Fentanyl 0.5-2mcg/kg, q20-60min
Ketamine 0.5-2mg/kg, q10-20min
Ketamine 0.5-2mg/kg bolus then 0.5-1mg/kg/hr
Midazolam 0.05mg/kg-NO Painl, q15-30m
Midazolam 0.05 mg/kg bolus IV x1 prn, then titrate 0.05-0.1mg/kg/hr IV gtt
Propofol 10-75 mcg/kg/min IV

VOCAL CORD VISUALIZATION MANEUVERS:

- **Ensure correct alignment-** External auditory meatus is aligned with sternal notch and head is in neutral to sniffing position.
- **BURP** = **B**ackward; **U**pward; **R**ightward; **P**ressure on thyroid cartilage.

RSI (Abbreviated: see RSI PROCEDURE as needed)

1. **Preoxygenate** (100% FiO_2 via mask or PPV as needed)
2. **Pretreat** (Premedicate) as able or mission allows (Atropine blocks reflex bradycardia in pediatric (<2y/o only) population)
3. **Induce** (Primary Sedation / Anesthesia)
4. **Paralyze** (Neuromuscular blocking agent)
5. **Wait for Fasciculation, Jaw Relaxation, Absence of Movement**
6. **Pass ET Tube or insert BIAD** (throughout attempt, ensure good O_2 saturation. If below 94% stop and provide PPV)
7. **Confirm Placement and Secure Tube**
8. **Continue Sedation and Paralytic** as needed per dosing time.

Note: Midazolam and Propofol should only be used for continued sedation when pain management is NOT a concern (i.e., Non Trauma Patient or Patient is already on adequate narcotic pain control).

Rescue Breathing Ventilation Rate Without Advanced Airway:

- **NEWBORN** = 40-60/min when performed without compressions
- **Infant / Child** = 1 breath / 3-5 seconds
- **Adult** = 1 breath / 5-6 seconds

VENTILATOR SETTINGS:

- Mode: AC, SIMV, or ASV
- Rate: 14 initially, then adjust PRN
- Tidal Volume: 6mL/kg initially, then adjust 4-8 mL/kg
- I:E = 1:2
- PEEP: 5
- FiO_2: 100% initially. Try to decrease FiO_2 as much as possible while keeping O_2 saturation > 93%.
- **Goal FiO_2 = 50-60% to conserve battery life and O_2, while maintaining patient SpO_2 >93%.**

AIRWAY CONFIRMATION

CLINICAL INDICATIONS:

- Post endotracheal intubation to confirm proper placement of endotracheal tube (ETT)

CONTRAINDICATIONS:

- None

PROCEDURE:

- Primary / First confirmation of proper placement is always good visualization of tube passing through cords.
- Provider or second individual should listen for bilateral breath sounds and absence of gastric sounds. Also evaluate for equal chest rise. Look for ETT fogging.
- Ensure ETT is at appropriate depth and good pilot cuff tension is present.
- **WAVEFORM CAPNOGRAPHY** is gold standard for patient airway monitoring.
- Capnometer: Place onto ETT and bag patient 2-3 breaths. Proper placement will result in color change to Gold / Yellow. Esophageal placement will result in a purple color. (**Gold = good**, **Barney = bad**) Change will only occur with perfusion (e.g. High quality CPR required.)
- Esophageal detection device: Squeeze bulb expressing all air out of the EDD. Place this onto end of ETT. Rapid refilling suggests proper placement (the rigid trachea does not collapse and therefore there is no obstruction to air return). Poor filling or no filling suggests improper placement (the flaccid esophagus will collapse around ETT preventing refilling).
- Pulse oxygenation: After a short delay (30-60 seconds in young children, particularly those with poor perfusion), the pulse oxygenation should increase to normal range (this is not reliable in excessively cold patients, methemoglobinemia, or CO poisoning). Do not extubate if other confirmation measures say it is in!

Document procedure, results, and vital signs.

At any time, doubt as to correct placement should prompt removal of tube, oxygenate with BVM, and re-attempt with BIAD before rescue airway!

BLIND INSERTION AIRWAY DEVICE (BIAD)

CLINICAL INDICATIONS:

Patient with inadequate respiratory drive or respiratory failure due to any reason (e.g., altered mental status, trauma, infection) other than airway burns, anaphylaxis, or other causes of airway swelling / obstruction.

CONTRAINDICATIONS:

- Massive upper airway trauma distorting anatomy
- Penetrating neck trauma

PROCEDURE:

Consider paralytic/analgesia/sedation medications when placing supraglotic airways devices. In any instance of BIAD placement, caregiver must be prepared for vomiting and aspiration.

- Prepare, position, and pre-oxygenate the patient with 100% O_2. Ensure patient on monitor if possible.
- Select appropriate size BIAD and ensure proper cuff inflation / deflation.
- Lubricate with water-soluble jelly.
- Advance tube towards posterior pharynx until seated in correct position.
- Inflate balloon as per package insert and attempt to ventilate with BVM.
- If good airflow / chest rise / PO_2, secure device in place and ventilate patient with BVM / Vent.
- If unable to ventilate / resistance, leave first BIAD in place, deflate balloon, and pass a second BIAD in the same manner as the first (second should only be able to enter the trachea as the first may have entered into the esophagus approx 5-10%). Once second BAID is in place, remove first and inflate the cuff on the second device. Attempt to bag as above. If successful, ventilate patient.

WARNING: BIADs may not prevent or block aspiration of gastric contents.

Document procedure, results, and vital signs.

FAILED AIRWAY

Criteria:

- **Unable to open airway**
- **Two (2) Failed intubation attempts by the most proficient technician on scene**
  - Assumes at least 1 attempt with Supraglottic Airway (unless contraindicated or appropriate size not available) and 2 attempts with ET Tube

OR

- **Intubation contraindicated due to anatomical abnormalities or major airway trauma**

All Attempts as Appropriate:

- **Reposition Airway (jaw-thrust for c-spine injury)**
- **Sweep & Suction (as needed)**
- **Heimlich Maneuver /Abdominal Thrusts / Back Slaps (as indicated)**

Able to Ventilate with BVM

NO → **(*See Pearls)** Attempt to:
Insert Oral Airway
AND/OR
Nasopharyngeal Airway (NPA)
(if NO basal skull fracture suspected)
→ **Continue BVM**

YES

Continue BVM

If adequate ventilation with BVM, continue BVM. If inadequate, continue with protocol.

CRICOTHYROIDOTOMY open, percutaneous (>10 y/o) or needle

Ventilate Patient (per age respiratory rate)

Repsiratory Rate: (breaths/min) without Advance Airway and *NOT* performing BLS.

Infant	30-60
Toddler	24-40
Preschooler	22-34
School Age	18-30
Adolescent	12-18

Pearls:

- Continuous pulse oximetry should be utilized in all patients with an inadequate respiratory function.
- Continuous $EtCO_2$ monitoring should be attached when available to monitor adequacy of ventilation.
- Contraindication for Oropharyngeal Airway (OPA: Intact gag reflex, conscious or semiconscious, severe facial trauma
- Contraindication for Nasopharyngeal Airway (NPA): Known esophageal disease, recent ingestion of caustic substances, severe facial trauma, possible nasal and adjacent (basilar skull) fracture
- **In the setting of significant facial/neck trauma or distortion of anatomy (i.e. angioedema) laryngoscope and intubation may be difficult or impossible. Based on physical examination of the airway, Cricothyroidotomy may be the initial airway of choice. Consider procedural sedation with Ketamine in awake patients.**
- **Cricothyroidotomy can be performed by all medics once approved by medical director. This should be utilized quickly with sever airway trauma or inability to intubate.**
- **Needle Cricothyroidotomy can be performed by all CCFPs once approved by medical director. This should be utilized quickly with severe airway trauma or inability to intubate.**

NASOPHARYNGEAL AIRWAY

CLINICAL INDICATIONS:

- Depressed mental status with need for airway augmentation to ensure patency / access.

RELATIVE CONTRAINDICATIONS:

- Patient at high-risk of aspiration and/or unable to protect airway
- Massive facial trauma, burns, or suspicion of basilar skull fracture (e.g., CSF otorrhea, Battle's sign, raccoon eyes, mechanism).

PROCEDURE:

- Position patient in the sniffing position.
- Select appropriate sized NP tube and lubricate with water-soluble jelly (can measure tube by placing exterior (lipped) end next to nare and tip should reach to angle of mandible).
- Select most patent nare, orient open angle medially, and pass tube in a posterior **– not superior –** direction. If resistance is met, attempt to corkscrew slightly or remove and attempt in other nare. If unsuccessful, try the next smallest sized tube.
- Pass tube until lip of NP tube rests against nare.
- Bag patient with BVM / mask as needed.

Document procedure, results, and vital signs.

Pre-Intubation Checklist

PRE-INTUBATION CHECKLIST	
INSTRUCTIONS FOR USE The Pre-Intubation Checklist serves as a final reference prior to administering a sedative and paralytic during a Rapid Sequence Intubation. Run the checklist to ensure preparation is complete before embarking on induction and paralysis. Refer to **RAPID SEQUENCE INTUBATION** for how to do an RSI.	
PLAN	☐ **Consider Dangerous Physiology Issue: SBP <100, SpO2 <94%, Metabolic Acidosis** ➢ Appropriately modify or avoid RSI in unstable patient ➢ **SBP < 100** → Consider resuscitation with IVF and vasopressors, Lower the dose of sedative ➢ **Sat < 94%** → Consider use of CPAP or BVM with PEEP valve to increase Mean Airway Pressure during Pre-Oxygenation ➢ **Severe Met. Acidosis** → Consider awake intubation or delayed sequence intubation with severe Metabolic Acidosis ☐ **Difficult Airway Evaluation** (LEMON, HEAVEN Criteria) ➢ Consider alternate airway, cricothyrotomy, or modify plan ☐ **Rapid Sequence Intubation, Delayed Sequence Intubation, Rapid Sequence Airway (SGA), or Cricothyrotomy** ➢ Choose the most appropriate technique for physiology and anatomy ☐ **Evaluate Cricothyrotomy Landmarks and Assess Procedural Difficulty** ☐ **Induction Agent / Paralytic** ➢ Choose and draw up appropriate Sedative and Paralytic ☐ **Push-Dose Pressors** ➢ Consider drawing up or administering Push-dose Epinephrine ☐ **Post-tube Sedation / Analgesia** ➢ Prepare Post-intubation Sedation and Analgesia ☐ **Consider Pretreatment 3-5 minutes prior** ➢ Fentanyl (TBI, CVA, MI, Ao Dissection); Atropine (Pediatric) ☐ **Failed Airway Plan Verbalized to the team** ➢ Discuss management plan for failed intubation
PATIENT PREPARATION	☐ **PreOx** ≥ 3 minutes with 15 LPM NRB or BVM + PEEP, and NC 4-6 LPM ☐ **Apneic Oxygenation with NC 15 LPM** once Induced/Sedated ☐ **Oxygenated ≥ 94%** prior to Induction ➢ Consider using CPAP or BVM + PEEP if unable to reach 94% with NRB ☐ **Positioning**: 30° Head-up for Pre-Ox, Ear-to-Sternal Notch for Intubation ➢ If C-Spine Consideration, open front of C-Collar and perform Manual In-line Stabilization ☐ **Monitor is Visible** (HR, BP, SpO2%, RR, etCO2) ☐ **Reliable IV Access Tested**
EQUIPMENT	☐ BVM (± PEEP Valve) on Oxygen ☐ Waveform Capnography on BVM (minimum Colorimetric) ☐ ± Video Laryngoscope powered on ☐ ± Back-up Laryngoscope ETT, ETT size down, 2x Stylet, 2x Syringe, Tube Securing ☐ Bougie ☐ OPA, NPA, SGA (iGel, LMA, King LT) ☐ Nasogastric or Orogastric Tube ☐ Cricothyrotomy Kit ☐ Suction on and accessible

Rapid Sequence Intubation

CLINICAL INDICATIONS:

- Airway Compromise or Inability to Protect Airway
- Respiratory Failure (Hypoxic, Hypercapnic)
- Expected Clinical Deterioration
  - >40% TBSA Burns, Severe Sepsis, TBI with AMS, etc
- Patient or Crew Safety
  - Combative, prolong transfer in critically sick, etc

CONTRAINDICATIONS:

- High likelihood of failure (Distorted Anatomy)
- Penetrating neck trauma

PROCEDURE:

- Make a plan, prepare patient and equipment (See **PRE-INTUBATION CHECLIST**)

Conduct seven "P" pneumonic **(7Ps):**

PREPARE	☐ **SOAPME:** - Suction: available, check for function - Oxygen: Pre-Oxygenation + Apneic Oxygenation - Airways: ETT, SGA (iGel, King, etc), Cricothyrotomy - Pharmacology: Induction, Paralysis, Post-intubation Sedation - Monitor: BP, HR, RR, SpO2%, etCO2 capnography, 4-lead - Equipment: Bougie, Laryngoscope, Video Laryngoscope, Cric Kit ☐ **Difficult Airway Evaluation** (LEMON or HEAVEN Criteria) - Consider alternate airway, cricothyrotomy, or modify plan ☐ **Evaluate Cricothyrotomy Landmarks and Assess Procedural Difficulty**
PRE-OX	☐ **PreOxygenate / Denitrogenate** ≥ 3 minutes or 8 Vital Capacity Breaths with 15 LPM NRB or BVM + PEEP, and NC 4-6 LPM ☐ **Oxygenated ≥ 94%** - Patients remaining <94% may require CPAP or BVM + PEEP safe O2 saturation ☐ **Apneic Oxygenation with NC 15 LPM** once Induced/Sedated
POSITIONING	☐ **30° Head-up for Pre-Oxygenation** ☐ **Ear-to-Sternal Notch for Intubation** ☐ **C-Spine Consideration:** Open front of C-Collar; perform Manual In-line Stabilization
PRETREAT	☐ **Resuscitate** with IVF or Blood Products and Push-Dose Pressors to ensure SBP>100mmHg ☐ **3 - 5 Minute prior to Sedative / Paralytic** - **Fentanyl** 3mcg/kg slow IV push to prevent Hypertension in head injury, cardiac ischemia, or aortic dissection - **Atropine** 0.02 mg/kg IV to prevent bradycardia in Peds (age <1y)
PARALYZE / SEDATE	☐ **Push** Ketamine or Etomidate; and then Rocuronium or Vecuronium ☐ **Apneic Oxygenate:** Turn Nasal Cannula to 15LPM once patient becomes drowsy ☐ **Monitor SpO2%** and Wait 45-60 second for adequate paralysis
PASS TUBE	☐ **Visualize Cords and Pass Tube**
POST-TUBE MANAGEMENT	☐ **Inflate Bulb and Begin Bagging** ☐ **Verify Tube Place with etCO2 waveform capnography** - Direct visualization, mist in tube, equal rise and fall, bilateral breath sounds with absent gastric sounds, improving SpO2%, etCO2 colorimetric gold color change x6 ☐ **Secure Endotracheal Tube with commercial securing device** ☐ **Place patient on Post-intubation Sedation**

RSI MEDICATIONS

Induction Agents:

Ketamine 1-2 mg/kg IV
Etomidate 0.3 mg/kg IV
Midazolam 0.1 mg/kg IV
Propofol 1-2.5 mg/kg IV

Paralytics:

Rocuronium 0.6-1.2 mg/kg IV
Vecuronium 0.08-0.15 mg/kg IV
Succinylcholine 1.0-1.5 mg/kg IV

Maintenance Sedation:

Ketamine 0.5-2 mg/kg IVP or 0.5-2 mg/kg bolus then 0.5-1mg/kg/hr
Propofol 10-75 mcg/kg/min
Midazolam .05 mg/kg IVP or .05 mg/kg bolus then 0.05-0.1mg/kg/hr

Push Dose Epi:

Epinephrine 5-20mcg IV q2-5min

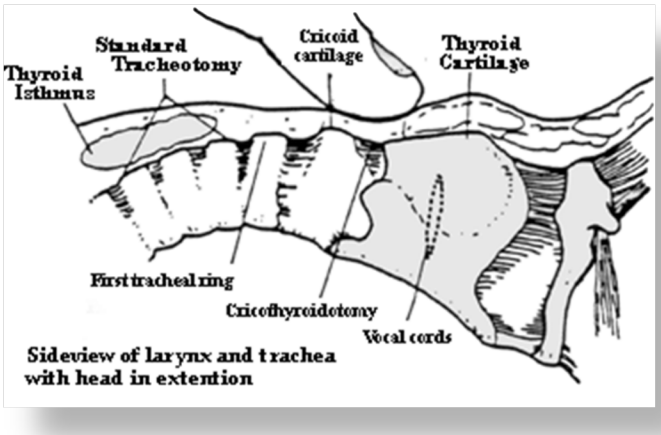
CRICOTHYROIDOTOMY

CLINICAL INDICATIONS:

- DIFFICULT AIRWAY- Airway can receive one (1) RSI attempt before calling it a failed airway. Two exceptions exist:
    - Inability to maintain proper O2 saturation above 90% or major trauma or obstruction
- NON-DIFFICULT AIRWAY- Airway can receive two (2) attempts so long as O_2 saturation is >90%.
- Inability to place / ventilate with blind insertion airway device (BIAD) or inability to provide ventilation with Bag-Valve mask.
- Massive facial trauma or neck trauma precluding the use of orotracheal intubation / BIAD.

CONTRAINDICATIONS:

- Age <12yo, abnormal anatomy. (See Needle Cricothyroidotomy)



PROCEDURE:

- Maintain patient in sniffing position or place them into sniffing position. Utilize inline stabilization if indicated.
- Oxygenate the patient with 100% O_2. Identify and cleanse the cricoid area with betadine / alcohol while oxygenating if possible.
- Before incising place static non-dominant hand using the middle and thumb to hold either side of the thyroid cartilage with the palm towards the head leaving and area between the fingers inferiorly to make the incision. This hand will not move until bougie is confirmed in the trachea.
- Using a scalpel, make an adequate (2-3cm) vertical incision over the cricothyroid membrane. Then, using hemostats, bluntly dissect until membrane fully visualized.
- Make an adequate horizontal incision through the cricothyroid membrane into the trachea. Spread incision with either hemostats or scalpel handle.
- At this point the index finger of the hand gripping the thyroid cartilage can be placed within the opening and the posterior aspect of the trachea can be palpated. The index finger maintains the tract should the airway be extremely bloody as this procedure is prone to be. The bougie/stylet is then placed along the index finger ensuring tracheal guidance and not subcutaneous plane dissection or posterior tracheal perforation into the esophagus.
- Once the bougie/stylet is inserted, pass a cricothyroid tube or 6-0 ETT into the trachea (if ETT used, only insert until just past the cuff, then inflate the cuff). Secure tube in place and begin to ventilate with BVM / 100% O_2.
- Confirm placement with capnography, capnometer, bilateral chest rise / breath sounds, good PO_2, $ETCO_2$, lack of increasing SQ air (a small amount is normal).
- **Document procedure, results, and vital signs.**

NEEDLE CRICOTHYROIDOTOMY

CLINICAL INDICATIONS:

- Child <10yo in whom open cricothyroidotomy is contraindicated with the following:
    - Failed intubation attempts x 3 by the most experienced provider present with inability to ventilate with BVM / high risk to ventilate with BVM.
    - Inability to place / ventilate with blind insertion airway device (BIAD).
    - Massive facial trauma or neck trauma precluding the use of orotracheal intubation / BIAD.

CONTRAINDICATIONS:

- Ability to ventilate adequately with BVM.
- Prolonged time to definitive care (relative).

NOTE: this technique requires a minimum of 50 psi O_2 or pressurized air flow and a special adapter to connect the line to the catheter hub; do not attempt otherwise.

PROCEDURE:

- Maintain patient in sniffing position or place them into sniffing position. Utilize inline stabilization if indicated.
- Oxygenate the patient with 100% O_2. Identify and cleanse the cricoid area with betadine / alcohol while oxygenating if possible.
- Using a 14Ga IV attached to a 3mL syringe, puncture the cricothyroid membrane at a 90º angle. **Do not advance needle once air returned.**
- Change angle to 45º and **advance Catheter only.** Should advance with no resistance. Remove needle and syringe.
- Secure catheter in place. Remove needle and plunger from syringe and place an adapter from a 7-0ETT on end of syringe in place of plunger. Attach this to the catheter.
- Attach a BVM attached to 100% O_2 to the adapter / syringe and ventilate. A large amount of resistance will be felt due to the small catheter size. Evaluate for chest rise and oxygenation. The provider needs to allow a 1:3 ratio of inhalation / exhalation.

Document procedure, results, and vital signs.

NOTE: Needle Cricothyroidotomy only allows for oxygenation, not ventilation. It is meant as a temporizing measure until definitive care – tracheostomy – can be performed at an MTF.
This airway should be used for only 20-30min maximum if able.

- Start working alternatives immediately after initiation - such as retrograde wire intubation, surgical cric with needle as an anatomical landmark.

SIMPLE (FINGER) and TUBE THORACOSTOMY

CLINICAL INDICATIONS:

- Pneumothorax + positive pressure ventilation or interfering with oxygenation
- Hemothorax + positive pressure ventilation or interfering with oxygenation
- Chest injury with suspected pneumo / hemothorax as above
- Evidence of tension pneumothorax after needle thoracostomy attempts

CONTRAINIDICATIONS:

- Stable patient oxygenating well, no tension PTX
- Blood clotting abnormalities (relative)

PROCEDURE (STERILE):

- Ensure all equipment prepared / available: Scalpel, 4X4 gauze, petroleum gauze, suture material (0 – 1-0 silk), 28Fr or larger chest tube, Heimlich valve / Water seal, large Kelly clamp x 2, betadine / skin cleanser, 1-2% lidocaine, 10mL syringe with needle for lidocaine, sterile gloves.
- If possible, position patient supine with shoulder flexed up and hand under his / her head.
- Identify and clean area of insertion with skin cleanser. Area of insertion should be over the 4th or 5th rib (3rd or 4th intercostal space) on injured side.
- If possible, with conscious patient, anesthetize the area with lidocaine. Take care to anesthetize the rib by passing needle perpendicular to skin until bone contacted and backing off slightly to inject lidocaine. May also anesthetize the pleura by advancing needle just until air returned and then injecting area while pulling back needle.
- Make incision in skin / SQ tissue overlying 5th rib. Ensure incision large enough for insertion of tube / finger (approximately 1-2 inch).
- Bluntly dissect tissue going over 5th rib with second clamp until pleura is reached, then puncture the pleura with the clamps. *Prevent overly deep insertion by using non-dominant hand to guide insertion or holding clamps in hand with index finger on shaft of the instrument.*
- Open clamps as wide as possible to enlarge the pleural opening and remove clamps. Blood and/or air may present at this time.
- Place finger into opening and palpate for any adhesions.
    - If Simple Thoracostomy **ONLY**, place vented chest seal over opening and position patient on ipsilateral side (if possible) and monitor for signs of tension pneumothorax.
    - If proceeding to tube placement, continue below ensuring tube is clamped closed on distal end before insertion.
- Advance tube into opening directing the tip of the tube posteriorly and superiorly towards the lung apex along the posterior aspect of the chest wall, ensuring all fenestrations are moved into opening. This method ensures tube will drain both hemo and pneumothoraces.
- Holding tube in place – Pad under tube with Kerlix and place modified chest seal around the tube ensuring seal of the wound and securing tube in place. If possible, stitch or staple tube into place.
- Apply suction to tube / Heimlich valve and remove clamp.

Document procedure, results, and vital signs.

CHEST TUBE TROUBLESHOOTING:

- Ensure tube not clamped / kinked and that suction is working.
- Ensure tube has not become dislodged.
- If evidence of tension PTX – remove attachments from end of chest tube (e.g., suction adapter, Heimlich valves, suction devices) to convert to open PTX. Troubleshoot attachments and re-apply if appropriate.

NEEDLE THORACOSTOMY

CLINICAL INDICATIONS:

Suspect a tension pneumothorax and treat when a casualty has significant torso trauma or primary blast injury and one or more of the following:

- Severe or progressive respiratory distress or tachypnea, absent or markedly decreased breath sounds on one side of the chest, chest pain, distended neck vessels, hemoglobin oxygen saturation < 90% on pulse oximetry, shock, traumatic cardiac arrest without obviously fatal wounds

* Note: If not treated promptly, tension pneumothorax may progress from respiratory distress to shock and traumatic cardiac arrest.

CONTRAINDICATIONS:

- None

PROCEDURE: **Note: This intervention is a BRIEF stopgap utilized in order to buy time for a definitive tube thoracostomy. It is not a solution unto itself.**

- Decompress the chest on the side of the injury with a 14-gauge or a 10-gauge, 3.25-inch needle/catheter.
- If a casualty has significant torso trauma or primary blast injury and is in traumatic cardiac arrest: decompress both sides of the chest before discontinuing treatment. Clean area if possible with betadine / alcohol, but do not delay treatment for this step.

Note: Either the 5th intercostal space (ICS) in the anterior axillary line (AAL) or the 2nd ICS in the mid-clavicular line (MCL) may be used for needle decompression (NDC.) If the anterior (MCL) site is used, do not insert the needle medial to the nipple line.

- The needle/catheter unit should be inserted at an angle perpendicular to the chest wall and just over the top of the lower rib at the insertion site. Insert the needle/catheter unit all the way to the hub and hold it in place for 5-10 seconds to allow decompression to occur.
- After the NDC has been performed, remove the needle and leave the catheter in place.
- The NDC should be considered successful if:
    - Respiratory distress improves; there is an obvious hissing sound as air escapes from the chest when NDC is performed (this may be difficult to appreciate in high-noise environments); hemoglobin oxygen saturation increases to 90% or greater (note that this may take several minutes and may not happen at altitude); casualty with no vital signs has return of consciousness and/or radial pulse.
- If the initial NDC was successful, but symptoms later recur:
    - Perform another NDC at the same site that was used previously. Use a new needle/catheter unit for the repeat NDC.
- If the second NDC is also not successful:
    - Fix appropriate circulation issues and consider finger/tube thoracostomy.

Document procedure, results, and vital signs.

VENTILATOR MANAGMENT

CLINICAL INDICATIONS:

- Patient received from transferring facility, intubated, and requires ventilator support.
- Patient requiring intubation in the field and subsequent respiratory support.

CONTRAINDICATIONS:

- Equipment malfunction / failure.

PROCEDURE:

- Turn on ventilator and ensure that machine is functional and battery is charged.
- Attach ventilator tubing and O_2 tubing to machine.
- If patient is a transfer and already on vent, maintain ventilator settings from medical treatment facility.

If patient "newly" on ventilator, initial settings include:

- **Mode:** Assist Control (AC) / CMV+ or ASV (Hamilton T1 only). AC / CMV+ are the preferred modes over ASV.
- **Tidal Volume (Vt):** Initially 6 cc/kg, (Ideal Body Weight (IBW) then adjust based on ventilatory needs (4-8 cc/kg)
    - IBW calculation for Predicted Body Weight in Kg:
        - Men: [(height in inches – 60) x 2.3] + 50
        - Women: [(height in inches – 60) x 2.3] + 45.5.
    - ***Tidal Volume should not be altered to fix ventilation, adjust rate instead for increased or decreased minute volumes***! Vt only gets changed for lung protection (i.e. to prevent barotrauma/volutrauma)
    - Reduce VT by 1 ml/kg at intervals ≤ 2 hours until VT = 6cc/kg PBW
    - SEE PBW Tidal Volume Chart Below
- **Rate (RR):** Initially 14, adjust based on CO2 (If CO2 >45mmHg) and ventilatory needs (10-30)
- **I:E:** 1:2 (Patients with obstructive lung diseases should have increased I:E around 1:4 or 1:5; If rate > 20 (most children) will need to titrate iTime down to achieve appropriate I:E ratio)
- **FiO2/PEEP (Should be adjusted in concert per the chart below)**
    - Start at 100% (1.0) FiO2 and PEEP of 5; PEEP no higher than 16 on Pediatrics w/out expert consult
    - Wait 5 minutes and assess SpO2

PA.10 Simple & Tube Thoracostomy
PA.11 Needle Thoracostomy
PA.12 Ventilator Management
PA.123 754 Preflight and Troubleshooting
PA.14 731 Preflight and Troubleshooting
PA.15 COVID-19 Management
PA.1p Pediatric Airway
PA.2 Airways Pearls
PA.3 Airway Confirmation
PA.4 BIAD
PA.5 Failed Airway
PA.4 Nasopharyngeal Airway
PA.7 Rapid Sequence Intubation
PA.7a Pre-intubation Checklist
PA.8 Cricothyroidotomy
PA.9 Needle Cricothyroidotomy

- Set the FiO2 to 30% and start titrating FiO2 and PEEP collectively based on the chart to achieve oxygenation goals. Go up every 5-10 minutes; quicker if low SpO2 sats develop.

Lower PEEP/higher FiO2

FiO_2	0.3	0.4	0.4	0.5	0.5	0.6	0.7	0.7
PEEP	5	5	8	8	10	10	10	12

FiO_2	0.7	0.8	0.9	0.9	0.9	1.0
PEEP	14	14	14	16	18	18-24

*** Hypotensive patients (MAP <70 or SBP <90) may respond negatively to increased PEEP causing decreased venous return. Monitor for increased hypotension and tachycardia.**

- **Alternate Higher PEEP settings**

Higher PEEP/lower FiO2

FiO_2	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
PEEP	5	8	10	12	14	14	16	16

FiO_2	0.5	0.5-0.8	0.8	0.9	1.0	1.0
PEEP	18	20	22	22	22	24

- **Oxygenation Goal:** PaO2 55-80 mmHg or SpO2 88-95%
- **Plateau Pressure Goal: ≤ 30 cm H2O**
  - Check Pplat (0.5 second inspiratory pause), at least q 4h and after each change in PEEP or VT.
  - **If Pplat > 30 cm H2O:** decrease VTby 1ml/kg steps (minimum = 4 ml/kg).
  - **If Pplat < 25 cm H2Oand VT< 6 ml/kg**, increase VT by 1 ml/kg until Pplat > 25 cm H2O or VT = 6 ml/kg.
  - **If Pplat < 30 and breath stacking or dys-synchrony occurs:** may increase VT in 1ml/kg increments to 7 or 8 ml/kg if Pplat remains < 30 cm H2O.
- **Alarm Settings:**
  - **High Pressure Alarm:** 10 cmH20 above peak airway pressure
  - **Low Pressure Alarm:** 5 cmH2O below peak airway pressure

    or
  - **High Pressure Alarm** 50% above the baseline PIP (1.5 x current PIP)
  - **Low Pressure Alarm** 50% below the baseline PIP (0.5 x current PIP)

    ** *Pressures will be determined by placing patient on vent for ~1-2 minutes and determining intrinsic peak inspiratory pressure. (Labeled as PEAK on 754 Ventilator (top right); Labeled as Ppeak on Hamilton T1 ventilator (top left).*
- Monitor waveform on machine and patient to ensure not "breathe stacking" – if this occurs, a high-pressure alarm may sound. However, if breath stacking suspected even in absence of alarm – disconnect tubing and allow exhalation. Increase I:E.

Predicted Body Weight and Tidal Volume (V_T)

Male PBW and Tidal Volume							
Height		Predicted Body Weight	ml per kg of PBW (total V_T)				
Ft'In"	Inches		4.0 ml	5.0ml	6.0ml	7.0 ml	8.0 ml
4'0"	48	22.4	90	112	134	157	179
4'1"	49	24.7	99	124	148	173	198
4'2"	50	27	108	135	162	189	216
4'3"	51	29.3	117	147	176	205	234
4'4"	52	31.6	126	158	190	221	253
4'5"	53	33.9	136	170	203	237	271
4'6"	54	36.2	145	181	217	253	290
4'7"	55	38.5	154	193	231	270	308
4'8"	56	40.8	163	204	245	286	326
4'9"	57	43.1	172	216	259	302	345
4'10"	58	45.4	182	227	272	318	363
4'11"	59	47.7	191	239	286	334	382
5'0"	60	50	200	250	300	350	400
5'1"	61	52.3	209	262	314	366	418
5'2"	62	54.6	218	273	328	382	437
5'3"	63	56.9	228	285	341	398	455
5'4"	64	59.2	237	296	355	414	474
5'5"	65	61.5	246	308	369	431	492
5'6"	66	63.8	255	319	383	447	510
5'7"	67	66.1	264	331	397	463	529
5'8"	68	68.4	274	342	410	479	547
5'9"	69	70.7	283	354	424	495	566
5'10"	70	73	292	365	438	511	584
5'11"	71	75.3	301	377	452	527	602
6'0"	72	77.6	310	388	466	543	621
6'1"	73	79.9	320	400	479	559	639
6'2"	74	82.2	329	411	493	575	658
6'3"	75	84.5	338	423	507	592	676
6'4"	76	86.8	347	434	521	608	694
6'5"	77	89.1	356	446	535	624	713
6'6"	78	91.4	366	457	548	640	731
6'7"	79	93.7	375	469	562	656	750
6'8"	80	96	384	480	576	672	768
6'9"	81	98.3	393	492	590	688	786
6'10"	82	100.6	402	503	604	704	805
6'11"	83	102.9	412	515	617	720	823
7'0"	84	105.2	421	526	631	736	842

PBW Males = 50 + 2.3 [height (inches) - 60]

Female PBW and Tidal Volume							
Height		Predicted Body Weight	ml per kg of PBW (total V_T)				
Ft'In"	Inches		4.0ml	5.0 ml	6.0 ml	7.0 ml	8.0 ml
4'0"	48	17.9	72	90	107	125	143
4'1"	49	20.2	81	101	121	141	162
4'2"	50	22.5	90	113	135	158	180
4'3"	51	24.8	99	124	149	174	198
4'4"	52	27.1	108	136	163	190	217
4'5"	53	29.4	118	147	176	206	235
4'6"	54	31.7	127	159	190	222	254
4'7"	55	34	136	170	204	238	272
4'8"	56	36.3	145	182	218	254	290
4'9"	57	38.6	154	193	232	270	309
4'10"	58	40.9	164	205	245	286	327
4'11"	59	43.2	173	216	259	302	346
5'0"	60	45.5	182	228	273	319	364
5'1"	61	47.8	191	239	287	335	382
5'2"	62	50.1	200	251	301	351	401
5'3"	63	52.4	210	262	314	367	419
5'4"	64	54.7	219	274	328	383	438
5'5"	65	57	228	285	342	399	456
5'6"	66	59.3	237	297	356	415	474
5'7"	67	61.6	246	308	370	431	493
5'8"	68	63.9	256	320	383	447	511
5'9"	69	66.2	265	331	397	463	530
5'10"	70	68.5	274	343	411	480	548
5'11"	71	70.8	283	354	425	496	566
6'0"	72	73.1	292	366	439	512	585
6'1"	73	75.4	302	377	452	528	603
6'2"	74	77.7	311	389	466	544	622
6'3"	75	80	320	400	480	560	640
6'4"	76	82.3	329	412	494	576	658
6'5"	77	84.6	338	423	508	592	677
6'6"	78	86.9	348	435	521	608	695
6'7"	79	89.2	357	446	535	624	714
6'8"	80	91.5	366	458	549	641	732
6'9"	81	93.8	375	469	563	657	750
6'10"	82	96.1	384	481	577	673	769
6'11"	83	98.4	394	492	590	689	787
7'0"	84	100.7	403	504	604	705	806

PBW Males = 45.5 + 2.3 [height (inches) - 60]

ARDSnet, NIH NHLBI ARDS Clinical Network Mechanical Ventilation V_T card

Troubleshooting: Airway compromise or lost airway in-flight

- If at any time patient begins to desaturate or develop respiratory problems, immediately disconnect ventilator and ventilate patient with BVM (with PEEP valve if available) and 100% O_2 while correcting issues utilizing the **D.O.P.E.** algorithm:
    - **Displacement:** ETT in place, patient not extubated/ tube did not move during transfer. If advanced – pull back to original length and attempt to bag; if tube has pulled farther out of trachea, DO NOT ATTEMPT TO ADVANCE IT without placement of bougie to verify tracheal placement. When advancing bougie, feel for tracheal rings or carina stop. If in doubt, pull tube and attempt BVM. If this fixes problem, continue to bag patient. Upon stabilization, consider alternative advanced airways (extraglotic airway or cric).

      ****If ETT moves freely, access for ETT bulb rupture.**
    - **Obstructions:** Assess for secretions in ETT. Suction if indicated.
    - **Pressure:** Ensure that a tension pneumothorax / hemothorax has not developed (if chest tube in place, ensure it is functioning/ not kinked or clamped). If tension pneumo/hemothorax suspected, perform immediate needle thoracostomy. Assess the need for escarotomy if circumferential burn. Consider additional paralysis and sedation if patient does not tolerate ventilation.
    - **Equipment:** Ensure that vent did not fail; O_2 tank not empty. If ventilator is operational, trace all tubes to the patient connection (airway tube, transducer line, exhalation line) ensuring patency and connections.

- **High pressure alarms / Peak airway pressure alarms** (Peak pressure >35 cm H_2O): Correct problems causing increased airway resistance and decreased lung compliance, including pneumothorax or pulmonary edema. Check ventilator to make sure prescribed tidal volume is being delivered. Check for linked/crushed tubing.
- **Air leaks causing low pressure alarms / volume loss**: Assess, correct air leaks in endotracheal tube, tracheostomy cuff, ventilator system; recheck ventilator to make sure prescribed tidal volume is delivered.
- **Ventilator desynchrony**: Agitation and respiratory distress that develop in a patient on a mechanical ventilator who has previously appeared comfortable represents an important clinical circumstance that requires a thorough assessment and an organized approach. The patient should not always be automatically re-sedated but must instead be evaluated for several potentially life-threatening developments that can present in this fashion.
- **Lung hyperinflation (air trapping) and auto-PEEP:** Dynamic hyperinflation is associated with positive end-expiratory alveolar pressure, or auto-PEEP. The physiologic effects include decreased cardiac preload because of diminished venous return into the chest. The reduced cardiac output that results from the reduction in preload can lead to hypotension and, if severe, to Pulseless Electrical Activity and cardiac arrest. Dynamic hyperinflation can also lead to local alveolar over-distention and rupture. Prevent, manage lung hyperinflation by decreasing tidal volume, changing inspiratory and expiratory phase parameters, switching to another mode, and correcting physiological abnormalities that increase airway resistance.

- **Document procedure, results, and vital signs.**

Ventilator Transfer Procedure

1. Ensure endotracheal tube is secure, document size and position of ETT at the teeth. Clamp tube immediately before disconnecting patient from vent in order to maintain PEEP and un-clamp only after connected to new vent circuit.

2. Ventilator settings should be coordinated with the transferring physician, anesthesia provider or respiratory therapist. Verify settings, review arterial blood gas (ABG) analysis, and current SPO_2 and $ETCO_2$ readings. Place those setting on transport vent and place patient on transport vent early to verify patient tolerance and compatibility.

3. ABG should be done within 30 minutes of flight. If time allows, patient should be on transport ventilator for at least 15 minutes prior to transport.

4. Ventilator settings for en-route care team should initially be matched to those of the transferring facility. Adjust settings PRN in order to maintain appropriate clinical parameters listed on first page of ventilator management protocol or transferring physician orders.

5. Ensure adequate sedation and analgesia medications are on hand.

VENTILATOR Terms

Volume-targeted modes: (Examples**: CMV** Continuous Mandatory Ventilation, **A/C** Assist/Control, **SIMV** Synchronized Intermittent Mechanical Ventilation) - Volume constant, inspiration terminates when preset V_t delivered. Peak airway pressure is variable and increases as needed to deliver prescribed V_t.

Pressure-targeted modes: (Examples: **PSV** Pressure Support Ventilation**, PCV** Pressure Controlled ventilation) - Volume variable, terminates when preset pressure reached. Volume is variable. Peak airway pressure is fixed, determined by set pressure level.

Adaptive Support Ventilation (ASV): Only available on the Hamilton T1. ASV provides intelligent ventilation mode that continuously adjusts respiratory rate, tidal volume, and inspiratory time depending on the patient's lung mechanics and effort.

Tidal volume (V_t): The volume of gas, either inhaled or exhaled, during a breath and commonly expressed in milliliters. V_t is generally set between 4-8ml/kg IBW (ideal body weight), to prevent lung over-distension and barotrauma.

Minute Ventilation (V_E): The average volume of gas entering, or leaving, the lungs per minute, commonly expressed in liters per minute. The product of V_t and RR (respiratory rate). Normal V_E is 5 – 10 L/min.

Inspiratory (I) **and Expiratory** (E) **time and I:E ratio**: The speed at which the V_t is delivered. Setting a shorter inspiratory time (I) results in a faster inspiratory flow rate. Average adult I time is 0.7 to 1 second. I:E ratio is usually 1:2 to 1:4

Positive end-expiratory pressure (PEEP): The amount of positive pressure that is maintained at end-expiration. It is expressed in centimeters of water. The purpose of PEEP is to increase end-expiratory lung volume and reduce air-space closure at end-expiration. Normal Physiologic PEEP is 5cm/H_2O.

Peak flow rate or peak inspiratory flow: The highest flow, or speed, that is set to deliver the V_t during inspiration, usually measured in liters per minute. When the flow rate is set higher, the speed of gas delivery is faster and inspiratory time is shorter.

Peak Airway Pressure (P_{AW}): Represents the total pressure that is required to deliver the V_t and depends upon various airway resistance, lung compliance, and chest wall factors. It is expressed in centimeters of water (cm H_2O).

Sensitivity or trigger sensitivity: Effort, or negative pressure, required by the patient to trigger a machine breath, commonly set so that minimal effort (-1 to -2 cm H_2O) is required to trigger a breath.

Provide Continuous Positive Airway Pressure (CPAP/BiPAP)

Contraindications: Suspected Pneumothorax, SBP < 90mmHg, facial trauma, lack of airway protective reflex (unconscious) respiratory or cardiac arrest, vomiting or active upper GI bleed

1. If possible, place patient in seated position and explain the procedure.

2. Perform an initial respiratory assessment and assess vital signs.

3. Use the mask-sizing gauge to measure the patient for the correct mask size and attach the mask to the circuit.

Note: The mask selected should come close to, but not in contact with the nasal bone, external nares, and upper lip.

4. Turn the unit on and operate device according to manufacturer's specifications.

    Initial settings: CPAP 5 cm H2O

    Initial settings: BiPAP 10 cm H2O/ 5 cm H2O

    Adjusted on most ventilators by using PEEP input button

5. Place the head straps on the patient IAW the manufacturer's instructions. Check for leaks and readjust if necessary.

6. Initiate positive airway pressure and adjust the CPAP/BiPAP pressure with the lowest continuous pressure that is effective.

7. Perform a respiratory assessment and titrate treatment to physiological goal.

8. Monitor patient continuously, assess and record vital signs at a minimum of every 5 minutes.

9. Observe for signs of deterioration or failure to respond to CPAP/BiPAP.

10. Consider low-dose benzodiazepine for anxiety and mask tolerance.

IMPACT 754 Ventilator Pre-mission checks and Troubleshooting

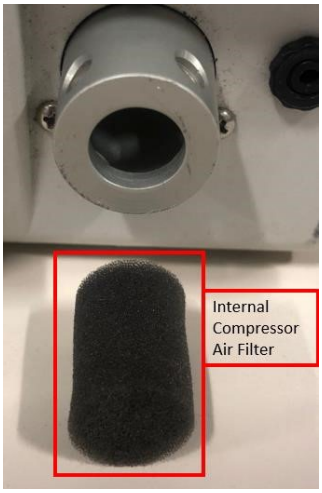
Routine Care

Clean unit and hose attachments with damp soapy cloth and wipe dry. Inlet filter may be removed to check for dirt or debris. Check metal hose couplings for thread wear and debris.

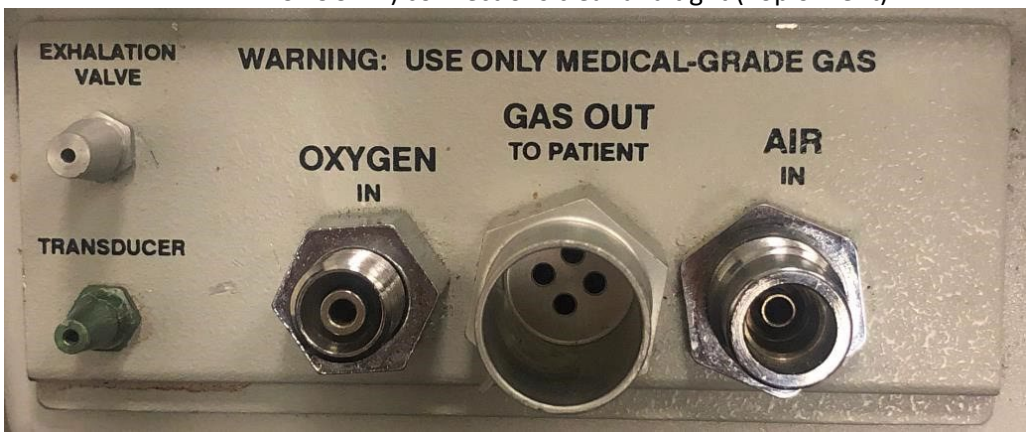
Duty Inspection

1. Power Off Checks
   a. Within calibration date (6 month maintenance cycle)

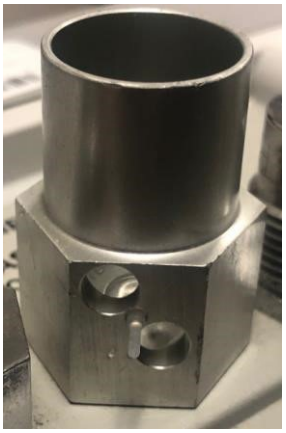
   b. Air inlet clear and filter in place (Right side of vent)



   c. Gas ("OXYGEN IN" and "AIR IN") and Patient ("EXHALATION VALVE" and "TRANSDUCER") connections clear and tight (Top of vent)



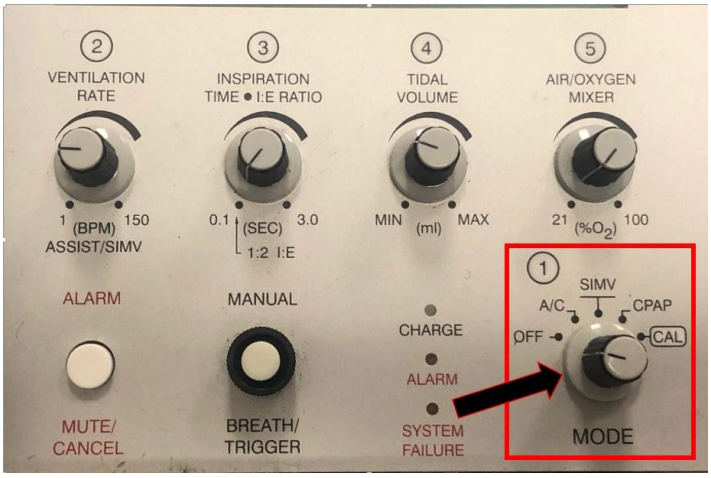
d. GAS OUT clear leaf valve installed and seated (Reseat if loose, Replace if missing) See replacement instructions at the end of this document.



e. Inspect green high pressure oxygen hose for cracks, dry rot, threads, Black O-ring (Replace if damaged).

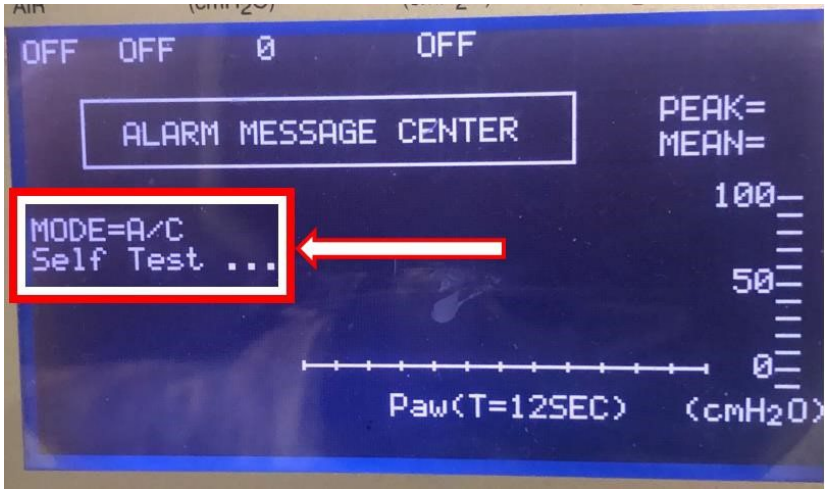
f. Connect ventilator to high pressure oxygen source, turn on Oxygen tank and ensure no leaks present. Turn off O2 when complete. (Conduct in environment conducive to hearing leaks)

2. Power On Checks
   a. Turn “MODE” knob (1) to desired setting (A/C, SIMV, CPAP)

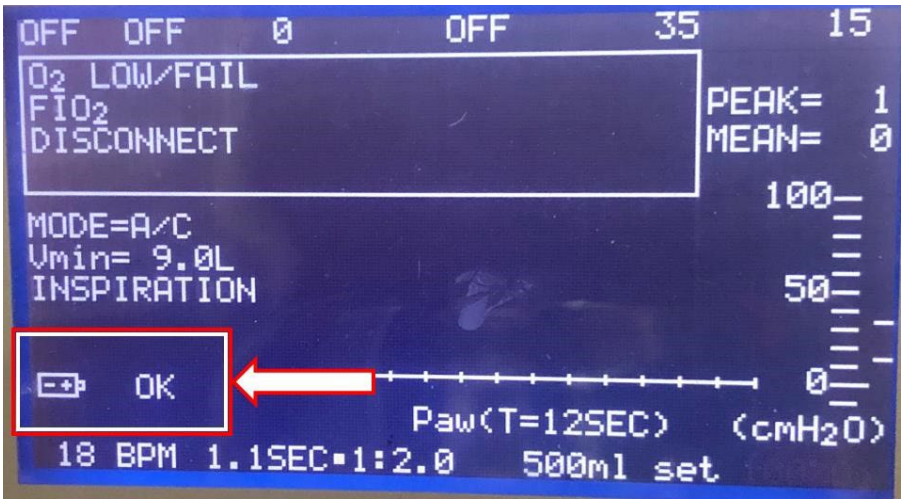


i. The ventilator will run a SELF-TEST upon set up. **CAUTION:** *SELF-CHECK must be performed with the disposable ventilator circuit disconnected. Ignoring this requirement could cause the SELF- CHECK process to sense a residual airway pressure leading to a SELF-CHECK failure*.

1. At this point, CAL is not required. If SELF-TEST results in a Calibration Failure, place (1) to CAL until CAL OK is displayed. If calibration fails, ventilator is deadlined.



b. Check BATT OK



c. Preset ventilator knobs to:

i. Rate (2) 18
ii. Inspiration Time (3) 1:2
iii. Vt (4) 500
iv. FiO2 (5) 100%
v. HIGH pressure alarm to 35 cmH2O vi. LOW pressure to 15 cmH2O

d. Turn OFF

e. Store Ventilator with Air Inlet and Gas Out Ports protected and covered.

Ventilator is now pre-set for duty and able to be rapidly employed as needed with minor adjustments to Vt based on patient ideal body weight and turning on O2 source

Weekly Inspections

ALL CAUTIONS, WARNINGS, AND NOTIFICATIONS THAT CORRESPOND WITH THE 754 SCREEN WILL BE IN ALL CAPS AND HIGHLIGHTED YELLOW

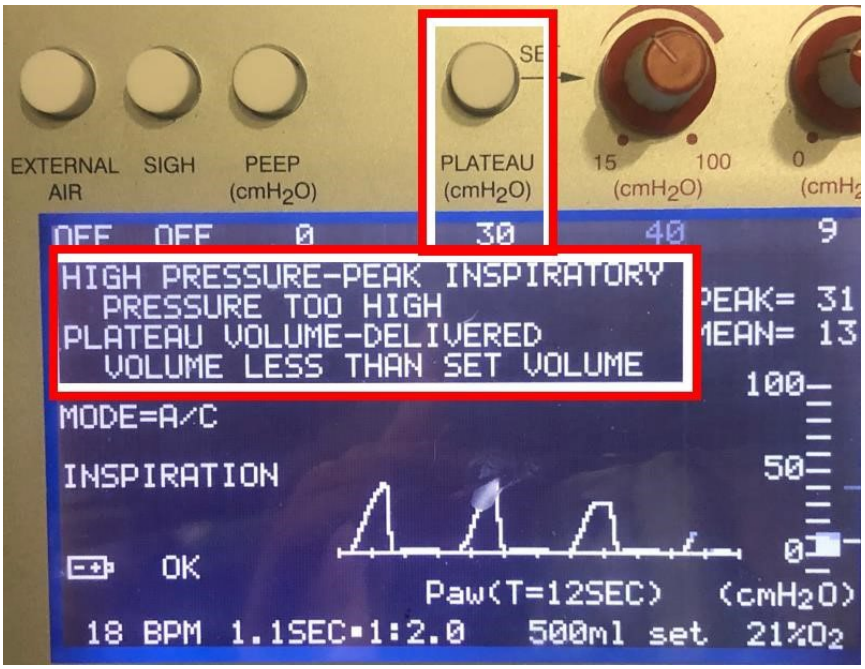
1. Complete Duty Inspection
2. Set FiO2 to 21%
3. Attach vent circuit to vent and field expedient training lung:
    a. Slide one large exam glove inside another.
    b. Wrap open end of the gloves around the patient end of the circuit tube.
    c. Secure with rubber band (DD1380) / Cut-off wrist bead of another glove / Penrose drain / Tape

4. Connect high pressure oxygen source and turn on O2
5. Turn vent on and allow respirations to begin (listen for compressor)
6. Set FiO2 to 100%
    a. Internal compressor will stop (audible)
7. Turn off oxygen source
    a. Ventilator will alarm and show
    b. "O2 LOW/FAIL-CHECK OXYGEN SOURCE/CONNECTIONS" and "FIO2-GAS MIX ERROR. CHECK SOURCE/SETTINGS/CONNECTIONS"
    c. Compressor will turn on (audible)

8. Set FiO2 to 21%.
9. Set HIGH pressure alarm to 5 cmH2O **below** PEAK.
    a. Ventilator will "stutter" and show "HIGH PRESSURE-PEAK INSPIRATORY PRESSURE TOO HIGH" warning and signal an alarm.

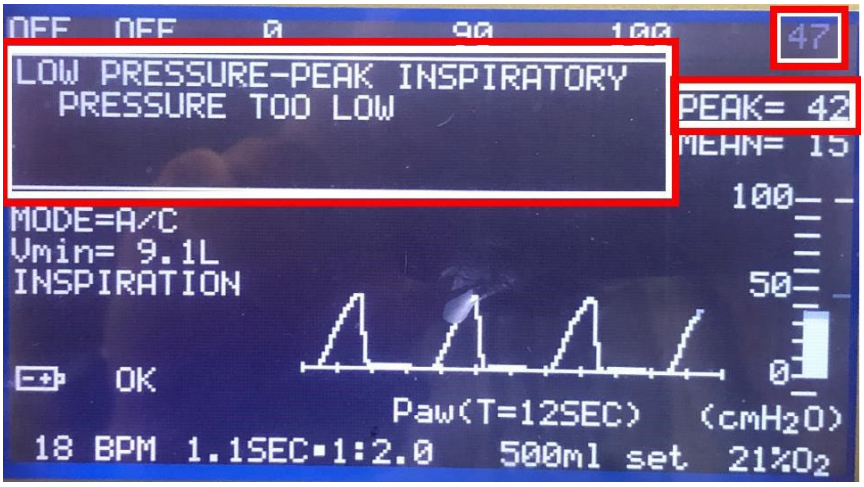
10. Turn PLATEAU pressure ON

    a. Ventilator will display "HIGH PRESSURE-PEAK INSPIRATORY PRESSURE TOO HIGH" and "PLATEAU VOLUME-DELIVERED VOLUME LESS THAN SET VOLUME" and trigger an alarm.



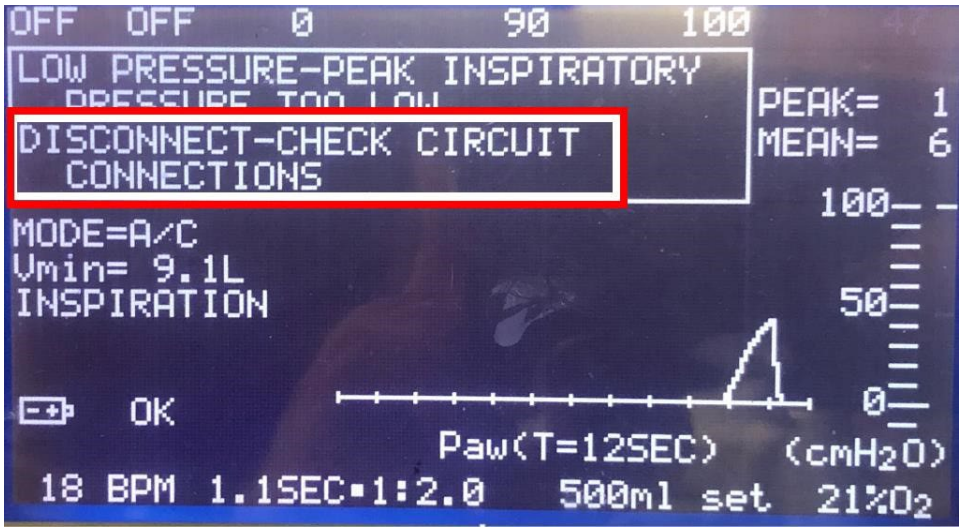
11. Turn HIGH Pressure alarm to 100.

12. Set LOW pressure alarm to 5 cmH2O **above** PEAK
    a. Ventilator will display "LOW PRESSURE-PEAK INSPIRATORY PRESSURE TOO LOW" and trigger an alarm.



13. Remove circuit from ventilator.

    a. Ventilator will display "DISCONNECT-CHECK CIRCUIT CONNECTIONS" and trigger an alarm.



14. Preset ventilator for use per Duty Inspection Power On Checks and turn off.

IN-FLIGHT EMERGENCY

*****These procedures should be practiced before performed on live patients*****

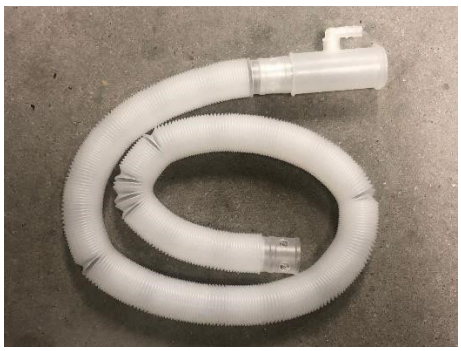
****Any known malfunction of ventilator should be addressed prior to flight. The following are not for routine use but for emergencies when alternate ventilitory measures are not available and long term BVM is not practical****

 Loss of high pressure O2 delivery when needs exceed 21% FiO2 (i.e. missing/unserviceable green high pressure hose.) will alarm and show "O2 LOW/FAIL-CHECK OXYGEN SOURSE/CONNECTIONS" on screen

NOTE: First Place Patient on BVM with supplemental O2. Second, check oxygen tank volume. Third, check the O2 lines and connections

Alternative methods to increase delivered oxygen content

1. Commercial oxygen reservoir kit for low pressure supply is available (Part # 820-0097-15)

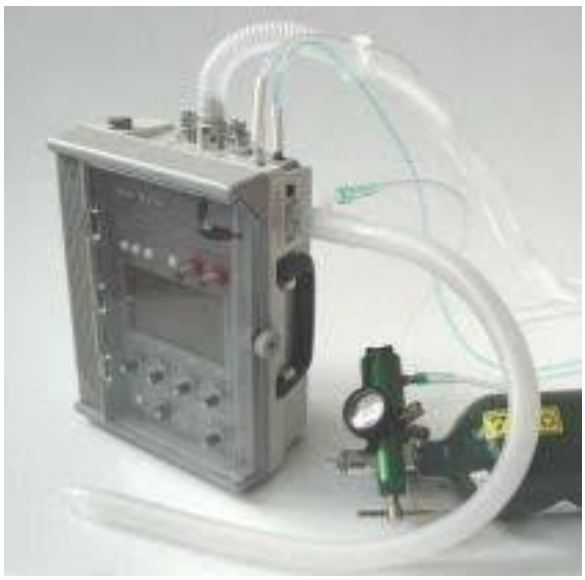


2. Oxygen reservoir fashioned from primary circuit and BVM
    a. Connect short portion of main circuit tube to the BVM and to the airinlet port.
    b. Connect BVM O2 hose to the BVM and the regulator.
    c. Set regulator to desired setting (~10LPM, but no lower than total minute volume.

3. Oxygen reservoir fashioned from second ventilator patient circuit.
    a. Cut/disconnect exhalation valve off of second ventilator circuit.
    b. Remove transducer fitting from exhalation valve at attach it to the main circuit.

c. Connect the transducer hose to the original transducer fitting and the other end to regulated oxygen source.
d. Connect the transducer fitting (still attached to the circuit) to the air inlet port.
e. Set regulator on O2 source to 10 LPM to deliver up to 99% FIO2.

NOTE: Ventilator circuit tubing will provide reservoir for 650-700 ml of O2. Vt of greater than 650-700ml may result in lower FIO2.



Missing or damaged "GAS OUT" leaf valve

1. Missing "GAS OUT" leaf valve will trigger an alarm, give a "DISCONNECT- CHECK CIRCUIT CONNECTIONS", no "PEAK" value will display, and little to no volume will be delivered to patient.

    a. Place patient on BVM with supplemental O2
    b. Perform DOPE (Dislodgment, Obstruction, Pneumothorax, and Equipment) assessment.
    c. Check "GAS OUT" leaf valve for installation and proper seating.
        i. If folded, use small object to gently unfold or push valve back into place
        ii. If missing, replace ventilator immediately if able. If unable to replace, cover GAS OUT side ports with occlusive dressing. (Replacing GAS OUT leaf valve is optimal but time consuming.)

WARNING: Occluding GAS OUT side ports will enable ventilator to provide full respirations, however, this will eliminate the antiasphyxia function these ports provide (Ventilator failure will result in increased resistance in spontaneous respiration) and strict surveillance must be kept on ventilator to ensure any further failure is caught immediately. Patient must immediately be transitioned to BVM in the event of any failure.

Compressor failure/alarms (may show CODE 2)

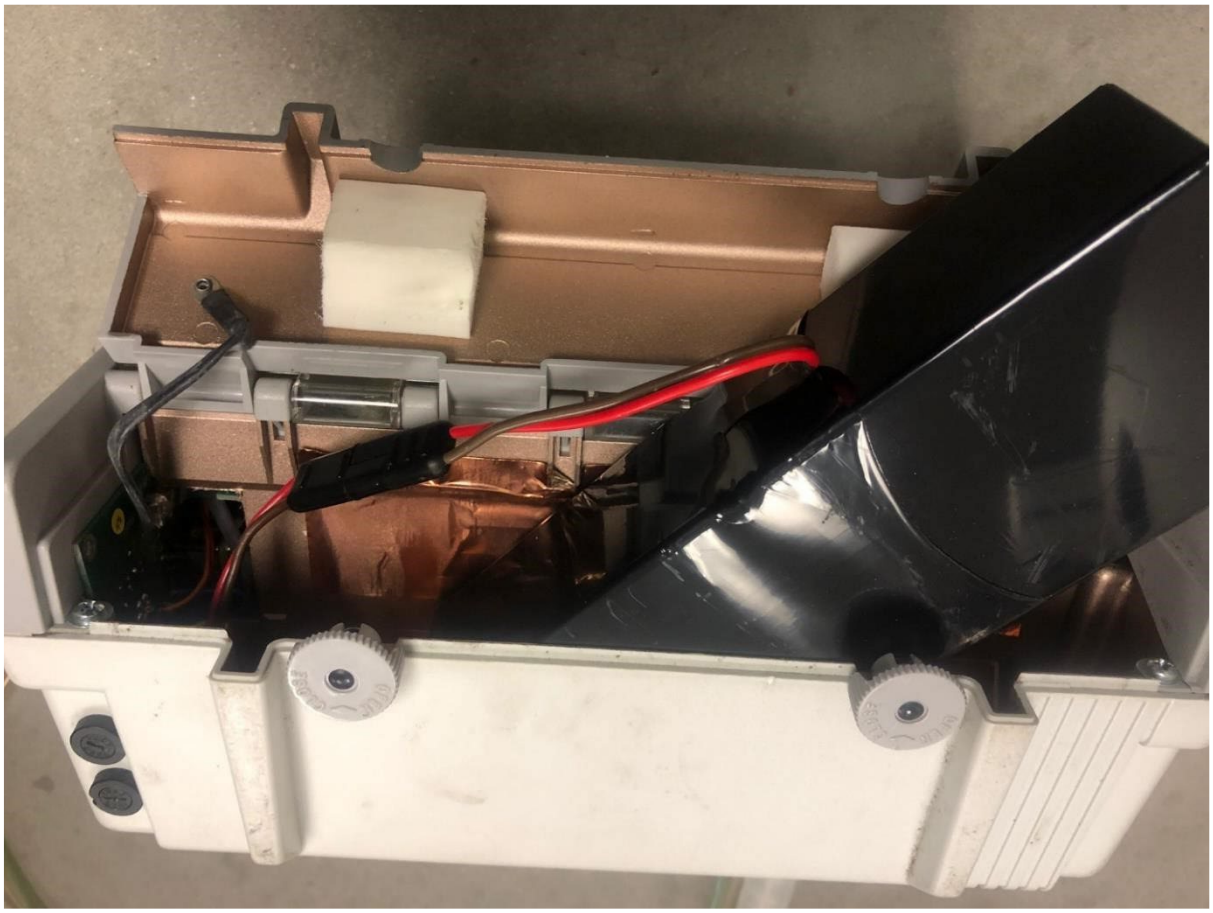
1. Place patient on BVM with supplemental O2
2. Cycle ventilator to OFF

3. Turn FiO2 knob (#5) to 100%
4. Cycle back on and to desired settings leaving FiO2 at 100%
    a. PEEP will have to be reset when vent is cycled on.

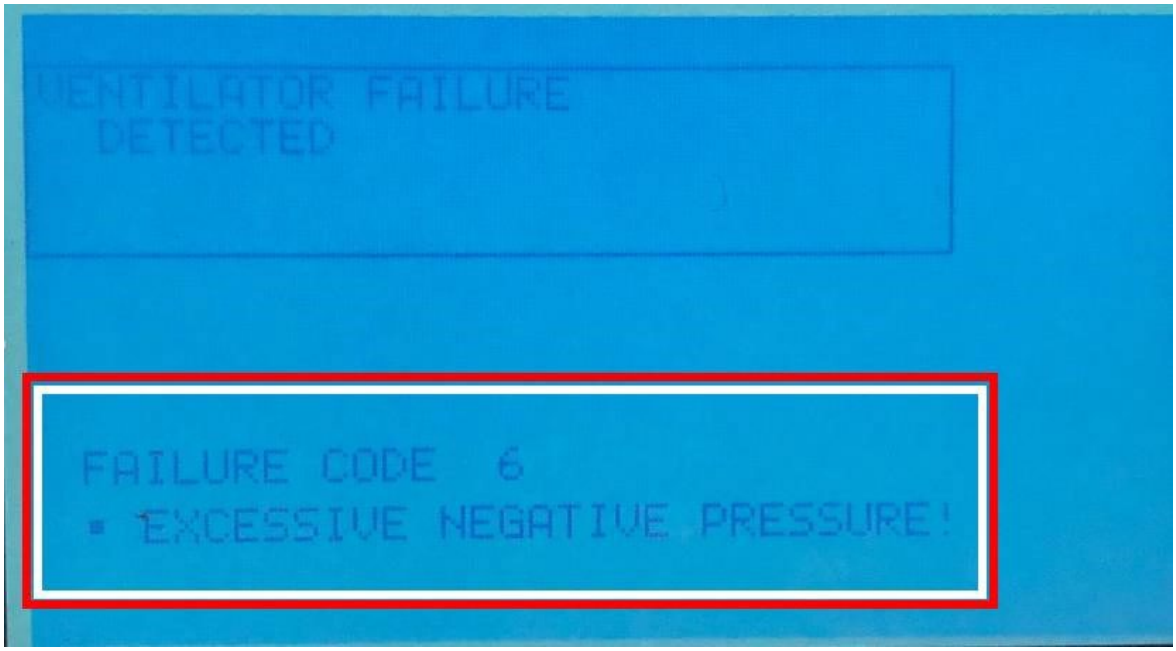
Note: This technique will transition the ventilator to using oxygen pressure instead of the compressor to drive ventilation and may hasten oxygen usage

 Battery Failure

1. Place patient on BVM with supplemental O2
2. Turn ventilator OFF
3. Replace ventilator battery with battery from 326M suction apparatus. (Per the manufacturer, they are the exact same!)
    a. 326M battery is in the same location as the 754.
4. Resume normal operations
    a. PEEP will have to be reset when vent is cycled on.



Fail Code 6
Suctioning to long with inline suction and/or patient inspiratory effort is significant enough to trigger.

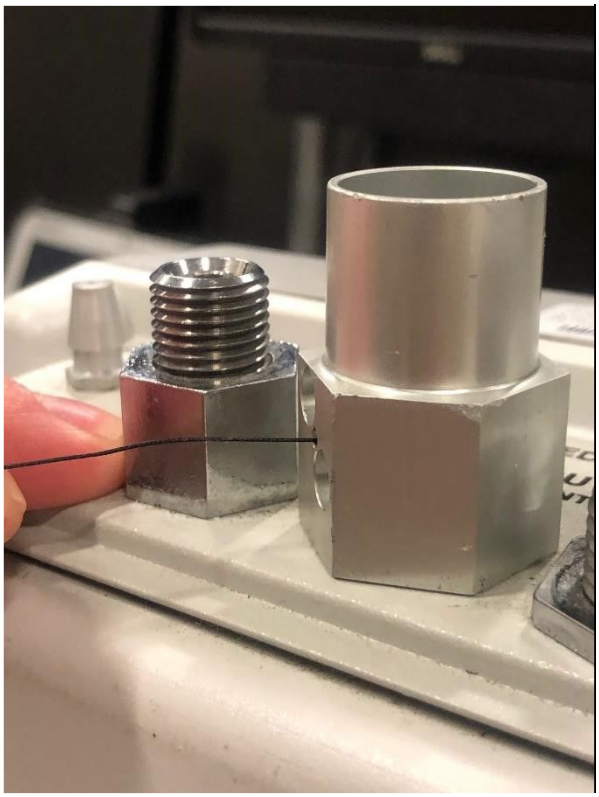


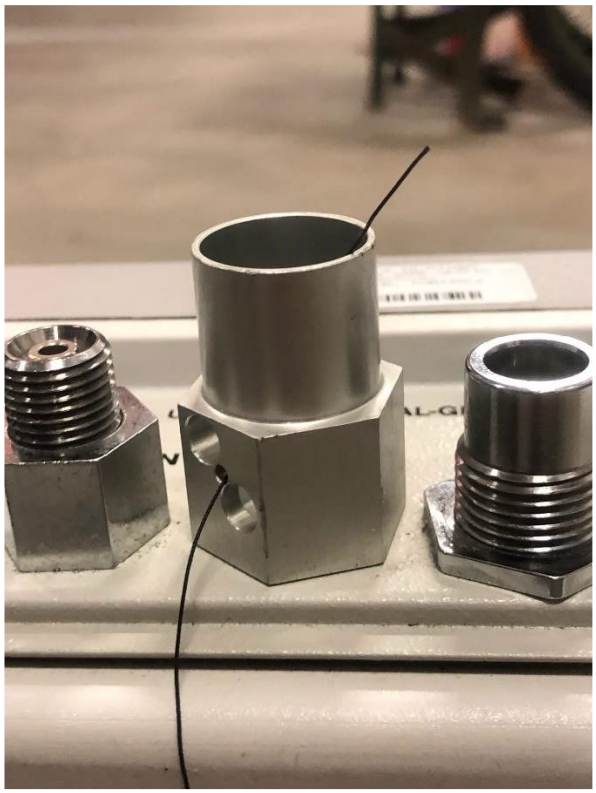
1. Place Patient on BVM with O2
2. Assess Patient
3. Cycle Vent off and on (will have to reset Peep)
4. Check vent settings
5. Place patient on ventilator

Document all failures of equipment and solutions on DD1380, DA4700, and in Joint Patient Safety Reporting (JPSR) registry https://health.mil/Military-Healthhttps://health.mil/Military-Health-Topics/Access-Cost-Quality-and-Safety/Quality-And-Safety-of-Healthcare/Patient-Safety/Joint-Patient-Safety-ReportingTopics/Access-Cost-Quality-and-Safety/Quality-And-Safety-of-Healthcare/Patienthttps://health.mil/Military-Health-Topics/Access-Cost-Quality-and-Safety/Quality-And-Safety-of-Healthcare/Patient-Safety/Joint-Patient-Safety-ReportingSafety/Joint-Patient-Safety-Reporting

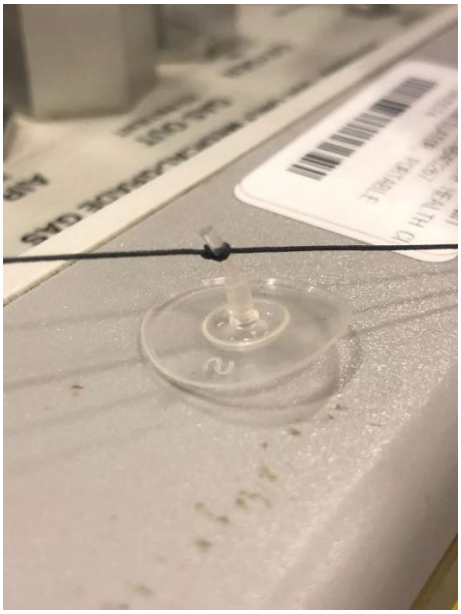
REPLACING GAS OUT LEAF VALVE

1 . Feed suture through small center hole.





2. Tie small square knot over end of tail of leaf valve.



3. Pull gentle tension on suture while guiding the leaf valve into place.

4. Maintain gentle traction against suture while applying pressure against the leaflet valve inside gas port with finger. Remove string once valve is seated. (Use caution to not apply too much tension to suture as leaf valve tail can tear.)

ALTERNATIVE FOR MISSING INTERNAL COMPRESSOR AIR FILTER

Ventilator inspiratory bacteria filter can be attached to air inlet (Missing air filters allow dust, debris, and/or moisture to be pulled into the ventilator compressor. This results in increased work-load of the ventilator leading to diminished battery life and eventual compressor failure)

Common Replacement Parts

Zoll/ NSN Part Numbers

-Zoll Part #: 820-0097-15 Oxygen reservoir kit for low pressure supply

-MEDSILS: OXYGEN ADAPTER BLEED-IN RESERVOIR FOR VENTILATORS

NSN: 6515-01-518-5060

-Zoll Part #: 704-0754-01 Battery Pack

-MEDSILS: BATTERY POWER SUPPLY USED ON VENTILATOR

NSN: 6130-01-468-8361

-Zoll Part #: 490-0005-00 Valve, Leaf

-MEDSILS: VALVE REGULATING SYSTEM PRESSURE

NSN 6530-01-464-0267

ZOLL 731 Ventilator Pre-mission Checks and Troubleshooting

Routine Care

- Keep the ventilator and its accessories clean at all times.
- Clean the unit's housing and hose connections with a damp, soap cloth
- For general decontamination, apply a 10% bleach solution with a damp cloth.
- After cleaning, thoroughly dry the unit with a lint free cloth. Make sure all exposed surfaces are cleaned and dried.

Duty Inspection

- Ensure the ventilator is clean and free of visible damage
- Inspect all accessories and connectors for signs of damage or excessive wear. Replace worn or defective items.
- Examine high pressure hose for cracking, discoloration, or disfigurement. Examine end connection fittings for damaged threads and sharp edges. Replace worn or defective hoses. *DO NOT attempt to repair hoses
- Examine the ventilator circuit for damage or wear including cracking or discoloration. If there are signs of physical degradation or the unit is indication ventilator circuit problems, replace the circuit
- Examine the filters and replace them if dirty of clogged
- Inspect the external AC/DC adapter, line cords, and DC power cables for wear or damage. Replace if worn or damaged.

*Recommended to use a disposable external filter when operating in areas where fine dust or dirt is airborne due to wind.

* The Zoll Ventilator can operate over the range of -25 to 49 degrees Celsius in emergency situations. When operating at high temperatures, you should remove the unit from its padded case, which allows the unit to pass heat into the surrounding environment.

Operational Test

Before attaching the patient to the ventilator, you must perform an Operational Test to ensure that the breathing circuit is properly attached and that the primary patient safety alarms, such as PATIENT DISCONNECT and AIRWAY PRESSURE HIH, are functioning properly.

1. Press the MANUAL BREATH button; gas should flow out of the patient connection each time the button is pressed.

2. Close the patient port with a gloved hand. During inspiratory phase, the HIGH AIRWAY PRESSURE LIMIT alarm should activate after 2 breaths.

a. If the AIRWAY PRESSURE HIGH alarm fails to activate, ensure all the tubing connections are secure, the exhalation valve is closing during inhalation, and that the High Airway Pressure Limit is set to 35 cm H2O or less.

3. After a breath or two, release the patient port while allowing the ventilator to operate. The PATIENT DISCONNECT alarm should activate.

4. Partially close the patient port to reset the PATIENT DISCONNECT alarm.

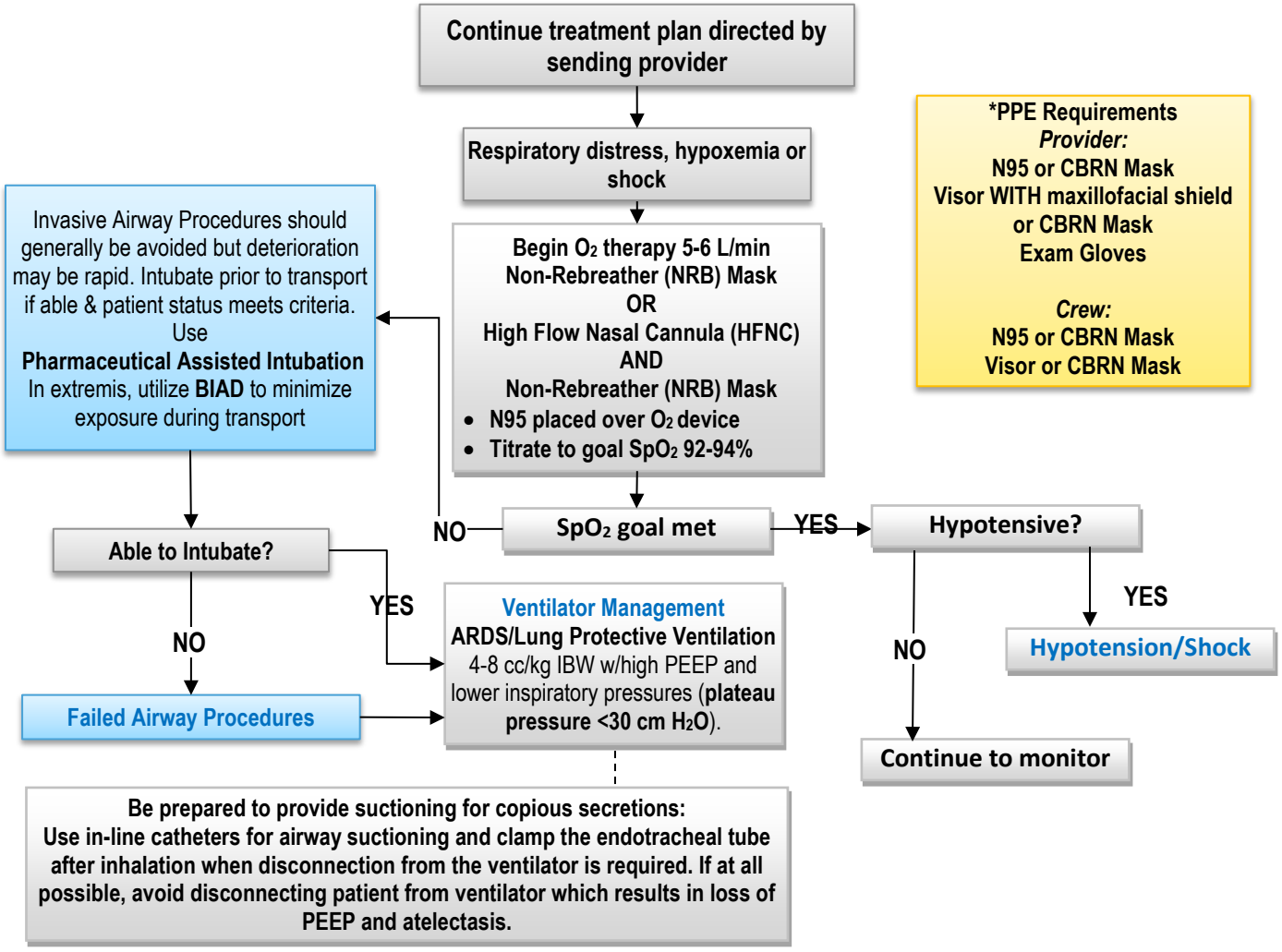
5. With no other alarms occurring, remove external power from the ventilator. The EXTERNAL POWER LOW/DISCONNECT alarms should activate. Reconnect external power to reset alarms. **MAY SKIP THIS STEP IF NOT CONNECTED TO EXTERNAL POWER**

6. If operating using internal battery, verify the Battery Icon indicates sufficient available battery capacity remains to support the anticipated duration of operation.

If either the HIGH AIRWAY PRESSURE, PATIENT DISCONNECT, or EXTERNAL POWER LOW/DISCONNECT alarms fail to activate, continue to manually ventilate the patient, replace the ventilator, and send the unit in for service.

COVID-19 Management

Criteria:
Only as last resort if all ground/fixed wing options have been exhausted. MEDEVAC crews WILL follow OTSG guidance for transport of COVID patients, and transport only if required PPE, PM, decon material and appropriate approval authorities are available BEFORE transport


Continue treatment plan directed by sending provider
Respiratory distress, hypoxemia or shock
Begin O_2 therapy 5-6 L/min
Non-Rebreather (NRB) Mask
OR
High Flow Nasal Cannula (HFNC)
AND
Non-Rebreather (NRB) Mask
N95 placed over O_2 device
Titrate to goal SpO_2 92-94%
SpO_2 goal met
NO
YES
Hypotensive?
YES
Hypotension/Shock
NO
Continue to monitor
Invasive Airway Procedures should generally be avoided but deterioration may be rapid. Intubate prior to transport if able & patient status meets criteria. Use
Pharmaceutical Assisted Intubation
In extremis, utilize BIAD to minimize exposure during transport
Able to Intubate?
YES
NO
Failed Airway Procedures
Ventilator Management
ARDS/Lung Protective Ventilation
4-8 cc/kg IBW w/high PEEP and lower inspiratory pressures (plateau pressure <30 cm H_2O).
*PPE Requirements
Provider:
N95 or CBRN Mask
Visor WITH maxillofacial shield
or CBRN Mask
Exam Gloves
Crew:
N95 or CBRN Mask
Visor or CBRN Mask
Be prepared to provide suctioning for copious secretions:
Use in-line catheters for airway suctioning and clamp the endotracheal tube after inhalation when disconnection from the ventilator is required. If at all possible, avoid disconnecting patient from ventilator which results in loss of PEEP and atelectasis.

Pearls:

- Recognize severe hypoxemic respiratory failure when a patient with respiratory distress is failing to respond to standard oxygen therapy. Prepare to provide advanced oxygen and ventilatory support. Patients may deteriorate rapidly, continuous monitoring is critical!
- Avoid fluids if not in shock. If required, use balanced crystalloids (LR) instead of unbalanced crystalloids (0.9% NS). If patient remains hypotensive, refer to **Hypotension/Shock**
- Do not prone position patients in flight; rehearse for emergency re-proning in event of accidental lost airway
- Favor HFNC over BiPAP/noninvasive ventilation (NIV) if early intubation and mechanical ventilation is not possible.
- Avoid use of nebulized medications, Bag Valve Mask ventilations (BVM), NIV, and suctioning when possible
- Avoid BiPAP if HFNC is unsuccessful and consider early intubation
- Perform continuous EtCO2 monitoring. Permissive hypercapnia is acceptable.
- If high pressure alarms are presenting, it may be necessary to reduce Vt if SpO2 and EtCO2 are within normal limits.
- *Post-mission Decon- Crewmembers should remain in full PPE until completion of mission, not just patient drop-off if aircraft is not being deconned at drop-off site

Epidemiologic risk factors	Exposure category	Recommended Monitoring for COVID-19 *(until 14 days after last potential exposure)*	Work Restrictions for Asymptomatic HCP
Prolonged close contact with a COVID-19 patient who was wearing a facemask (i.e., source control)			
HCP PPE: None	Medium	Active	Exclude from work for 14 days after last exposure
HCP PPE: Not wearing a facemask or respirator	Medium	Active	Exclude from work for 14 days after last exposure
HCP PPE: Not wearing eye protection	Low	Self with delegated supervision	None
HCP PPE: Not wearing gown or gloves[a]	Low	Self with delegated supervision	None
HCP PPE: Wearing all recommended PPE (except wearing a facemask instead of a respirator)	Low	Self with delegated supervision	None
Prolonged close contact with a COVID-19 patient who was not wearing a facemask (i.e., no source control)			
HCP PPE: None	High	Active	Exclude from work for 14 days after last exposure
HCP PPE: Not wearing a facemask or respirator	High	Active	Exclude from work for 14 days after last exposure
HCP PPE: Not wearing eye protection[b]	Medium	Active	Exclude from work for 14 days after last exposure
HCP PPE: Not wearing gown or gloves[a,b]	Low	Self with delegated supervision	None
HCP PPE: Wearing all recommended PPE (except wearing a facemask instead of a respirator)[b]	Low	Self with delegated supervision	None

*****Report all potential high and medium exposures to Flight Surgeon as soon as possible*****

Self-Monitoring with delegated supervision in this setting means HCP perform self-monitoring with oversight by their Flight Surgeon or delegate. On days HCP are scheduled to work, healthcare facilities could consider measuring temperature and assessing symptoms prior to starting work.

Ventilator Exchange Checklist

Two person procedure- One for airway, one for ventilator.

- All persons in the room/area in full PPE
- All equipment gathered and field prepped
- Transport ventilator preset / staged in sequence with circuit- ETCO2- *Filter-Inline Suction
- Temporarily hyper-oxygenate with 100% FiO2 prior to exchange
- Allow patient to inhale
- Clamp tube at end of inhalation (ensure use of smooth clamps or pad ET tube)
- Place primary/in use ventilator in Stand-by (ex. T1) or disconnect inspiratory limb from ventilator side- ensuring to minimize contamination from in-use vent and circuit
- Break the circuit
- Place transport ventilator on patient
- Unclamp ET Tube (ensure tube is open)
- Verify Ventilation

* HME/viral filters should be placed as close to patient as possible and in accordance with manufacturer guidelines

HEMORRHAGE CONTROL PROCEDURES

CLINICAL INDICATIONS:

- Hemorrhage

CONTRAINIDICATIONS:

- None

PROCEDURE:

- Rapid bleeding and/or arterial source recognized (extremities, axial, inguinal) – immediate application of extremity and/or junctional tourniquets, as appropriately needed, to stop bleeding.
- For compressible (external) hemorrhage not amenable to limb tourniquet use Combat Gauze, the CoTCCC hemostatic dressing of choice.
    - Alternative hemostatic adjuncts:
        - Celox Gauze, ChitoGauze, XStat (best for dep, narrow-tract junctional wounds) or iTCLamp (may be used alone or in conjunction with hemostatic dressing or XStat).
    - Hemostatic dressings should be applied with at least 3 minutes of direct pressure (optional for XStat). Must apply adequate force to compress vessels. If size of wound and bleeding are concerning for adequate control, place hemostatic dressing as close to the bleeding vessel as possible followed by 5 min of direct pressure. Each dressing works differently, so if one fails to control bleeding, it may be removed and a fresh dressing of the same type or a different type applied. (Note: XStat is not to be removed in the field, but additional XStat, other hemostatic adjuncts, or trauma dressings may be applied over it.) If bleeding continues, apply a pressure dressing to the wound if applicable.
    - If unable to control bleeding in extremity wounds with above, apply tourniquet. Note: immediate transition to a tourniquet in an extremity wound hemorrhage is preferred.
    - In penetrating injuries to the abdomen, after removing blood, hemostatic dressings should be pushed into the wound and pressure held for five minutes to encourage clotting. Do not remove bandage after placement. Penetrating abdominal/thoracic injuries require a large amount of pressure to compress vessels.

- In pelvic wounds – utilize pelvic binding to limit capacity for hemorrhage (tie pelvis with sheet/commercial binder).
- For external hemorrhage of the head and neck where the wound edges can be easily re-approximated, the iTClamp may be used as a primary option for hemorrhage control. Wounds should be packed with a hemostatic dressing or XStat, if appropriate, prior to iTClamp application. DO NOT APPLY on or near the eye or eyelid (within 1cm of the orbit).
  - The iTClamp does not require additional direct pressure, either when used alone or in combination with other hemostatic adjuncts.
  - If the iTClamp is applied to the neck, perform frequent airway monitoring and evaluate for an expanding hematoma that may compromise the airway. Consider placing a definitive airway if there is evidence of an expanding hematoma.
- Administer IVFs as per guideline – use care with internal bleeding so as not to raise SBP above 80mmHg. MAP should be greater than >60mmHg.
- Consider 2 Grams TXA if significant blood loss.

Document procedure, results, and vital signs.

*****Clear endpoints for fluid resuscitation remain unclear. Resuscitation should be geared towards patient response to therapy. A MAP greater than 60mmHg or a systolic BP between 70-80mmHg is a reasonable goal in trauma patients without a head injury. A MAP between 80-110mmHg or systolic pressure between 110-160mmHg is a recommended goal in patients with a head injury.**

MAP= Mean Arterial Pressure: MAP = [(2 x diastolic BP) + systolic BP] / 3)

Hemorrhage Classification (ATLS)

	Class I	Class II	Class III	Class IV
Estimated Blood Loss (mL)	<750 15%	750-1500 15-30%	1500-2000 30-40%	>2000 >40%
Heart Rate (min)	Normal to slightly elevated	Mild Tachycardia >100-119	Tachycardia 120-140	Tachycardia >140
Respiratory Rate (min)	Normal 12-20	Mild Tachypnea 20-24	Tachypnea 24-40	Tachypnea 24 - >40
Blood Pressure (from baseline)	Normal or slightly elevated	SBP with mild decline	SBP decreased*	SBP decreased (<90mmHg)
Urine Output (mL/hr	Normal > 30	Slight decrease 20-30	Decreased 5-15	Negligible <5
Capillary Refill	1-2 seconds	2 seconds	>2 seconds	> 3 seconds
Mental Status and Skin (color/texture)	Normal or slightly anxious	Mildly anxious, skin may become cool, clammy	Anxious, confused, skin cool, clammy	Confused, lethargic, skin will be cool/cold, pale

TOURNIQUET APPLICATION

CLINICAL INDICATIONS:

- Extremity trauma with continued hemorrhage or amputation.

CONTRAINDICATIONS:

- None

PROCEDURE: All medical personnel should be regularly practiced in deploying and applying all CoTCCC approved tourniquets. Tourniquets should be pre-set and removed from wrapping (ready for immediate use and application).

Initial HASTY placement (over uniform, clearly proximal to bleeding. If site of life-threatening bleeding is not readily apparent, place the tourniquet "high and tight" as proximal as possible on the injured limb.) HASTY tourniquet placement is appropriate for initial treatment of massive hemorrhage or hemorrhage while in care under fire phases. Reassess all HASTY placement tourniquets and asses if hemorrhage is manageable by other methods while in tactical field care or transition to tactical evacuation care. If tourniquet is necessary to manage hemorrhage, replace all HASTY placement tourniquets with DELIBERATE placement tourniquets, preferably prior to patient evacuation, per the following steps:

- Remove clothing as necessary to visualize bleeding area.
- Place tourniquet (commercial or any 2" wide piece of fabric, leather, etc.) directly on skin proximal to wound. Tourniquet should be placed at least 2-3" above bleeding site, proximal or distal to joints, as appropriate.
- Tighten tourniquet by twisting included rod (commercial) or piece of 6" rigid material (e.g., stick) until bleeding stops. If converting from HASTY to DELIBERATE tourniquet placement, loosen HASTY tourniquet. If bleeding is not well controlled with the first tourniquet, apply a second tourniquet side-by-side with the first.
- Secure ends of tension bar to prevent unwinding.
- Document presence of tourniquet and time of placement. ("T" signifies tourniquet). Do not cover tourniquet. Recheck tourniquet intermittently (q 15min) and after any movements to ensure no new bleeding/loosening has occurred.
- **TCCC recommendations:**
    - Limb tourniquets … should be converted to hemostatic or pressure dressings as soon as possible if three criteria are met: the casualty is **not in shock**; it is possible to **monitor the wound closely** for bleeding; and the tourniquet is **not being used to control bleeding from an amputated extremity**. Every effort should be made to convert tourniquets in less than 2 hours if bleeding can be controlled with other means.
    - **Convert all necessary HASTY tourniquets to DELIBERATE tourniquets as soon as tactically feasible.**
    - Do not remove a tourniquet that has been in place more than 6 hours unless close monitoring and lab capability is available.

Document procedure, results, and vital signs.

JUNCTIONAL TOURNIQUET APPLICATION

CLINICAL INDICATIONS:

• High level amputation not amendable to a standard tourniquet, non-compressible hemorrhage in a transition zone (inguinal and axilla), and pelvic immobilization.

CONTRAINDICATIONS:

• None

PROCEDURE: All medical personnel should be proficient in deploying and applying all available tourniquets. Junctional tourniquets (JT) should be pre-set and removed from wrapping (ready for immediate use and application). Junctional tourniquets should be applied according to manufacturer's instructions.

• Remove clothing as necessary to visualize area of application if possible. Remove objects from patient's pockets or pelvic area. Slide device into place as necessary to proper position.

• Tighten tourniquet by twisting or pumping up balloon/bladder until bleeding stops. (depends on JT used)

• Secure all straps in order to ensure security of device.

• Document presence of tourniquet and time of placement on patient (forehead). ("T" signifies tourniquet). Do not cover tourniquet.

• Recheck tourniquet intermittently (q 15min) and after any movements to ensure no new bleeding/loosening has occurred.

• Junctional tourniquets are recommended to be in place for up to **four** hours.

• ***If using a JT with pump device, additional inflation may be necessary with changes in altitude.

• The uniqueness of junctional tourniquets do not lend themselves to conversion well and should be left to Roles with surgical capability. Use caution if attempting Junctional Tourniquet Conversion. Must have high index of suspicion that injury is compressible and can be managed by other adjuncts.

Document procedure, results, and vital signs.

TOURNIQUET CONVERSION

CLINICAL INDICATIONS:

- Wounds that have high possibility of compressible hemorrhage control with hemostatic or pressure dressings where hemorrhage was originally controlled by a tourniquet

CONTRAINDICATIONS:

- Patient showing signs and symptoms of hypotensive/hemorrhagic shock
- Tourniquets controlling hemorrhage for amputated or partial-amputated extremity.
- Tourniquets that have been in place >6 hours.
- Unable to monitor wound for bleeding post tourniquet conversion due to task saturation, limited visibility or poor positioning.

PROCEDURE: Limb tourniquets and junctional tourniquets should be converted to hemostatic or pressure dressings as soon as possible if no above contraindications are present.

Every effort should be made to convert tourniquets in less than 2 hours if bleeding can be controlled with other means. **Do not remove a tourniquet that has been in place more than 6 hours**.

- Confirm patient is not showing any signs of hypotensive/hemorrhagic shock.
- With Tourniquet in place, attempt to pack wound with hemostatic dressing and apply a pressure dressing.
    - Combat Gauze is the CoTCCC hemostatic dressing of choice
    - Alternate hemostatic adjuncts:
        - Celox Gauze
        - ChitoGauze
        - XStat (best for deep, narrow-tract junctional wounds)
        - iTClamp (may be used alone or in conjunction with hemostatic dressing or XStat)
- Loosen but don't remove the tourniquet by unwinding the windlass until pulses return and closely monitor for return of bleeding for 5 minutes.
- If bleeding returns, retighten tourniquet until loss of distal pulse and document procedure failure.
- If no bleeding returns, loosen tourniquet completely but leave loosely looped around limb and monitor for return for bleeding for 5 minutes.
- If bleeding returns, retighten tourniquet until loss of distal pulse and document procedure failure.
- If no bleeding returns, document procedure success and time. Continue to monitor and assess for bleeding.

Document procedure, results, and vital signs.

VASCULAR ACCESS (INTRAVENOUS)

CLINICAL INDICATIONS:

- Need for intravascular access to provide resuscitative fluids and/or medications.
- Anticipated need for intravenous access in emergency patients.

CONTRAINDICATIONS:

- Injuries proximal to IV site/ipsilateral to IV site (relative).

PROCEDURE:

- Prepare all necessary equipment: PPE, tourniquet, IV catheters, alcohol/betadine wipe, saline lock or IV tubing, IVFs if administering, and tape/securing device.
- Ensure all IV tubing/saline locks flushed prior to attempting IV.
- Place venous tourniquet proximal to anticipated IV puncture site.
- Identify vein to be cannulated and cleanse overlying area with alcohol/betadine.
- While holding traction on skin/vessel, cannulate the vessel (use a shallow angle of attack with the needle). Once flash returned, advance slightly to ensure catheter in vessel, then advance catheter only fully into vessel (should pass without resistance).
- While holding pressure proximally on vein and maintaining catheter position, remove tourniquet and needle. Attach NS flush and flush IV – this fluid should flow easily into the vein – any resistance suggests missed attempt or “blown” vein. (Note: If blood samples being drawn – they should be taken prior to removing tourniquet and always prior to flush (after flushing – may obtain dilute sample which will alter results.)
- Secure catheter using transparent dressing or tape.
- Repeat until 2 IV sites have been established and are functional.

Document procedure, results, and vital signs.

VASCULAR ACCESS (INTRAOSSEOUS)

CLINICAL INDICATIONS:

- Need for intravascular access to provide resuscitative fluids and/or medications with inability to obtain adequate peripheral intravascular access (2 failed attempts or greater than 90sec).
- Anticipated need for intravenous access in emergency patients.

CONTRAINDICATIONS:

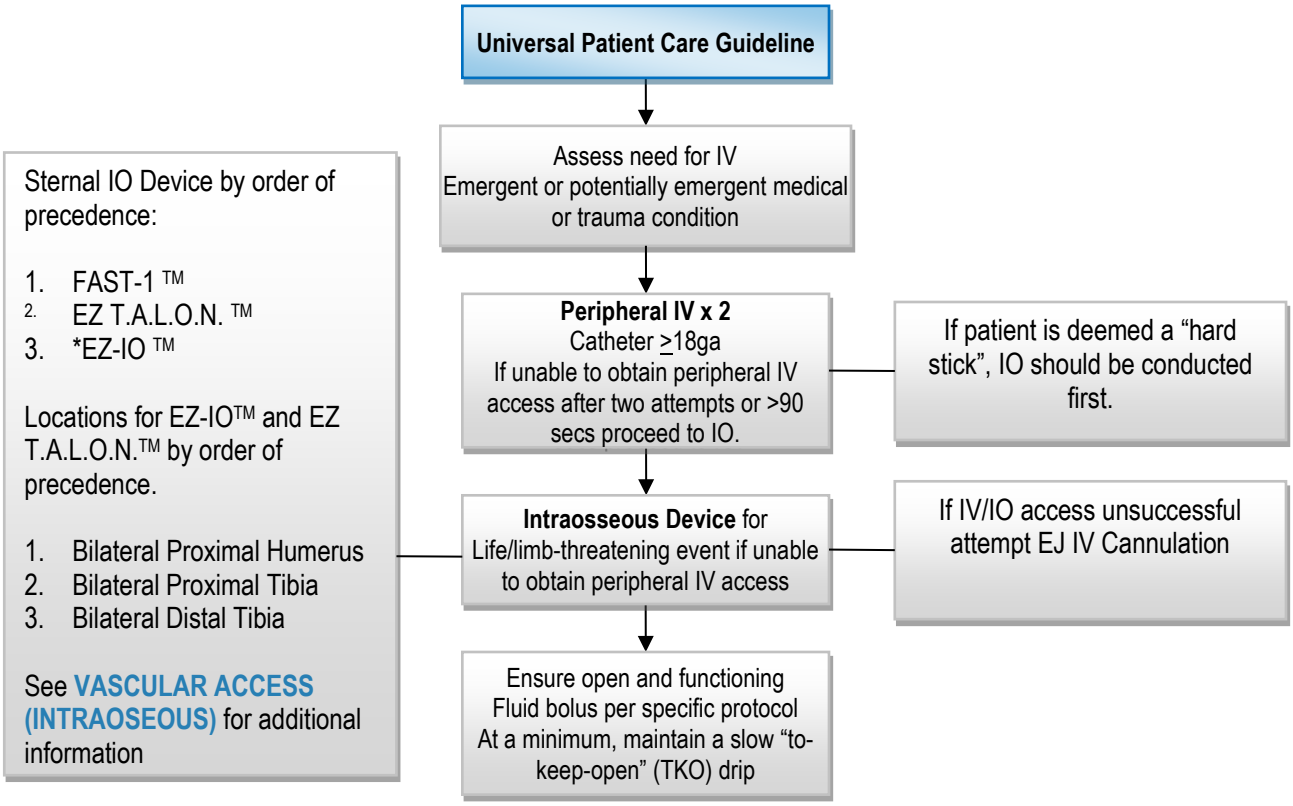
- **Only absolute contraindication is fracture at affected site or prior IO attempt in the same bone.**
- Cellulitis overlying puncture site (relative contraindication).
- Injury (not fracture) proximal to puncture site (relative – site dependent).
- FAST Tactical™ device contraindicated in pediatric patients less than 18 years old.

PROCEDURE:

- Prepare all necessary equipment: PPE, IO device, betadine scrub, and IV tubing.
- Ensure all IV tubing/saline locks flushed prior to attempting IV.
- Identify appropriate puncture area as follows:
  - **FAST Tactical™**
    - **Sternum – follow manufacturer instructions or training guidelines.**
  - **EZ IO™**
    - **Proximal Humerus (YELLOW 45mm) – 1 to 2 cm above the surgical neck into the most prominent aspect of the greater tubercle lateral to intertubercular (bicipital) groove, aiming 45-degrees downward towards contralateral hip.**
    - **Distal Femur (peds, BLUE 25mm) – Proximal to patella (max 1cm) and 1-2cm medial to midline.**
    - **Proximal tibia (BLUE 25mm or PINK 15mm) – 2cm (2 finger widths) distal to tibial tuberosity on medial aspect.**
    - **Distal tibia (BLUE or PINK) – 2cm (2 finger widths) proximal to medial malleolus.**
  - **Manual IO**
    - **Proximal tibia and distal tibia – same as EZ IO™ site.**
- Cleanse site well as failure to appropriately disinfect the area can lead to bone infections.
- Applying firm pressure, puncture skin at 90° angle (45 degree down for Humeral IO), puncture bone (felt as loss of resistance, give or "pop").
- Confirm placement by (1) needle felling firm in bone and (2) aspiration of blood/bone marrow. If unable to aspirate blood, attempt to aspirate after the flush
- Flush IO catheter with normal saline. May add 2% preservative-free Lidocaine without epinephrine to flush to decrease pain (2mL or 40 mg in adults, 0.5mg/kg not to exceed 40mg in pediatric).
- Constantly monitor for increased tension in muscular compartments as misplacement into a compartment with subsequent fluid administration can lead to iatrogenic compartment syndrome.
- With the exception of adult proximal humerus insertions, routinely inserting the needle set to the hub is not recommended technique.

Document procedure, results, and vital signs.

IV / IO PROTOCOL


Universal Patient Care Guideline
Assess need for IV
Emergent or potentially emergent medical or trauma condition
Peripheral IV x 2
Catheter ≥18ga
If unable to obtain peripheral IV access after two attempts or >90 secs proceed to IO.
If patient is deemed a "hard stick", IO should be conducted first.
Intraosseous Device for
Life/limb-threatening event if unable to obtain peripheral IV access
If IV/IO access unsuccessful attempt EJ IV Cannulation
Ensure open and functioning
Fluid bolus per specific protocol
At a minimum, maintain a slow "to-keep-open" (TKO) drip
Sternal IO Device by order of precedence:
1. FAST-1 ™
2. EZ T.A.L.O.N. ™
3. *EZ-IO ™
Locations for EZ-IO™ and EZ T.A.L.O.N.™ by order of precedence.
1. Bilateral Proximal Humerus
2. Bilateral Proximal Tibia
3. Bilateral Distal Tibia
See VASCULAR ACCESS (INTRAOSEOUS) for additional information

Pearls:

- **GAIN VASCULAR ACCESS** where available based upon patient
- Any pre-hospital fluids or medications approved for IV use may be given through an intraosseous line – including blood products.
- All trauma patients or potentially ill patients should have **AT LEAST TWO functioning** IV / IO lines whenever possible.
- Upper extremity IV sites are preferable to lower extremity IV sites.
- Following IV attempt failure and IO attempt failure, external jugular lines can be attempted for life-threatening events with no peripheral access.
- Utilize EZ-IO™, FAST-1™, EZ T.A.L.O.N.™ or unit Medical Director approved IO device.
    - Sternal or humeral head sites are preferred over all other sites.
        - (Tibia is preferred for pediatrics).
    - Correct needle size is critical for the EZ-IO; use of universal/adjustable depth needle or:
        - Yellow - 45mm for humerus and *heavy sternal
        - Blue - 25mm for adult *sternum/tib
        - Pink - 15mm for children and *sternal/tib
    - Pressure infusion bag is recommended for IO starting at 300mmHg

*NOTE: Use of EZ-IO in sternal is off label emergency procedure only see VASCULAR ACCESS (INTRAOSEOUS)

VASCULAR ACCESS via CENTRAL CATHETERS

CLINICAL INDICATIONS:

- In the presence of a life threatening condition, with clear indications for immediate use of medication or fluid bolus. (Not for prophylactic IV access.)

CONTRAINDICATIONS:

- Suspected infection at skin site.

PROCEDURE:

- Determine the type of catheter present: PICC, Broviac, Hickman, Groshong Mediport, etc.

Procedure for peripherally inserted Central Catheter (Cook, Neo-PICC, etc.) and Tunneled Catheter (Broviac, Hickman, Groshong, etc.):

- Prepare equipment:
  - 2 - 3 10 ml prefilled syringes of 0.9% NaCl
  - Sterile gloves (if available)
- If more than one lumen is available (PICCs, Hickmans and Broviacs can have one, two, or three lumens), select the largest lumen available.
- Vigorously cleanse the cap of the lumen with chlorhexidine or 70% alcohol prep pad, allow to dry.
- Unclamp the selected catheter lumen and using a prefilled 10 ml syringe:
  - Vigorously flush the catheter using a pulsating technique and maintaining pressure at the end of the flush to prevent reflux of fluid or blood
  - If catheter does not flush easily (note that a PICC line will generally flush more slowly and with greater resistance than a typical intravenous catheter), re-clamp the selected lumen and attempt to use another lumen (if present)
  - If unable to flush any of the lumens, the catheter is unable to be used
- Attach primed IV administration set and observe for free flow of IV fluid.
  - Utilizing an IV pump, set the flow rate based on the patient condition and IAW SMOG

Document procedure, results, and vital signs.

Procedure for implanted catheter (Port-a-Cath, P.A.S. port, Medi-port):

- Prepare all necessary equipment:
  - Non-coring, right angle needle specific for implanted vascular access ports
  - 2 - 3 10 ml prefilled syringes of 0.9% NaCl
  - Sterile infusion port cap
  - Sterile gloves (if available)
  - Sterile occlusive dressing large enough to completely cover the insertion site
- Identify the access site; usually located in the chest.
- Vigorously cleanse the cap of the lumen with chlorhexidine or 70% alcohol prep pad, allow to dry.
- Attach the infusion port cap to the end of the non-coring, right angle needle tubing.
- Prime the non-coring needle with attached tubing with saline using one of the prefilled 10 ml syringes. Leave the syringe attached to the tubing.
- Palpate the port to determine the size and center of the device.
- Secure the access point port firmly between two fingers and firmly insert the non-coring needle into the port, entering at a direct 90° angle.
- Aspirate 3 – 5 ml of blood with the syringe.
  - If unable to aspirate blood, re-clamp the catheter and do not attempt further use
  - Asking the patient to cough may facilitate access of the port
- Flush the catheter with 3 – 5 ml 0.9% NaCl using a prefilled 10ml syringe.
  - If catheter does not flush easily, do not attempt further use
- Attach IV administration set and observe for free flow of IV fluid.
  - Utilizing an IV pump, set the flow rate based on the patient condition and IAW SMOG
- Cover the needle and insertion site with the sterile occlusive dressing.

Document procedure, results, and vital signs.

CATHETER	SIZE	MAX FLOW RATE
PICC	Less than 2.0 fr	125 mL/hr
PICC	Greater than 2.0 fr	250 mL/hr
Groshong PICC	3 fr	240 mL/hr
Groshong PICC NXT	4 fr	540 mL/hr
Groshong PICC NXT	5 fr	200 mL/hr
Hickman/Broviac	8 – 9.5 fr	3000 mL/hr

PEARLS:

- Do not exceed recommended flow rates.
- Avoid taking a blood pressure reading in the same arm as the PICC.
- Only non-coring, right angle needles specific for implanted ports are to be used for vascular access devices that are implanted in the patient. These are generally not carried MEDEVAC units but may be provided by the patient.
- Priming the tubing of the non-coring needle **is essential** to prevent air embolism.
- There are many peripherally inserted, tunneled and/or implanted ports options. Providers should do their best to discern what option the patient has. Patient may be carrying a reference/wallet card about their device.
- PICC lines will not tolerate rapid infusions or infusions under pressure.

VASCULAR ACCESS via External Jugular Vein Cannulation

CLINICAL INDICATIONS:

- In the presence of a life threatening condition, with clear indications for immediate use of medication, blood or fluid bolus. It should only be used when a peripheral IV site cannot be established (Not for prophylactic IV access.)

CONTRAINDICATIONS:

- Inability to obtain any other suitable peripheral IV access
- Administer IV fluids or blood
- Administer medications

Equipment:

- IV start kit (alcohol swabs 4 x 4s, tourniquet, tape)
- Large bore IV catheter (14 or 16 gauge)
- IV fluid tubing

PROCEDURE:

- Explain the procedure to the patient
- Select the insertion site
- Find the landmarks midway between the angle of the jaw and the midpoint of the clavicle.
- Turn the patient's head away from the intended site of insertion. Consider placing the patient in the Trendelenburg position or holding the thumb over the vein to facilitate insertion.
- Insert the IV catheter pointing towards the ipsilateral acromioclavicular joint until a flash fills the chamber of the catheter, then advance the catheter over the stylet and remove the stylet.
- Attach the IV fluids to the catheter and infuse to verify the intravenous line is patent and dose not infiltrate.
- Secure the IV catheter using tape and a Tegaderm dressing or a clear occlusive dressing.
- Dispose of sharps in an approved biohazard container.
- **Document procedure, results, and vital signs.**

Complications:

- Infiltration
- Hematoma formation
- Cellulitis/infection
- Thrombosis
- Phlebitis

ENROUTE DAMAGE CONTROL RESUSCITATION (DCR)

Indications:

- **Systolic BP <100mmHg**
- **Heart Rate >100 bpm**
- **Hematocrit <32%**
- **pH <7.25**

Injuries associated with need for DCR:

- **Above the knee traumatic amputation (especially if pelvic injury present)**
- **Multi-Amputation**
- **Penetrating injury to chest or abdomen**
- **Intra-abdominal/thoracic hemorrhage**
- **2 regions positive on eFAST scan**
- **Lactate > 2.5**

Continued From: Hypotension Guideline

Trauma Fluid Hierarchy

- Whole Blood (low-titer grp O if available)
- pRBCs, plasma, platelets 1:1:1
- pRBC's, plasma 1:1
- Crystalloid (Plasmalyte-A)

IN THE ABSENCE OF ALL BLOOD PRODUCTS, BEGIN/CONTINUE RESUSCITATION AT STEPS FOLLOWING UTILIZATION OF BLOOD PRODUCT

****THE NEED FOR ONGOING DCR SHOULD BE RELAYED TO RECEIVING FACILITY ASAP TO FACILITATE ACTIVATION OF APPROPRIATE RESOURCES****

Blood Products IAW Trauma Fluid Hierarchy:
Target SBP >100 (>110 TBI)
See Blood Component Therapy Guideline

If No TXA given prior and <3hrs from time of injury/surgery:
TXA 2 Grams / IV/IO / 100ml .09% NS / Bolus or IVP (see drug card)

If 1 Gram TXA given prior and <3hrs from time of injury/surgery:
TXA 1 Gram IV/IO (see drug card)
If >3hrs from time of injury/surgery:

IV Calcium – 30 mL10%Calcium Gluconate
Or **10mL of 10% Calcium Chloride (see pearls)**

If continued decompensation due to uncompressible hemorrhage

Consider 125ml Boluses Plasmalyte A to target MAP > 65 mmHg

Rule out other sources for hypotension (Hemo/Pneumothorax or Tamponade)

Optimize Hypothermia Management:

- **Fluid Warmer**
- **HPMK or Blankets**
- Cabin Heat

Optimize Oxygenation/Ventilation

- **$ETCO_2$-35-45**
- **SpO2 >94%**

At Any Point, Once BP Controlled:

- **Continuous Monitoring**
- **Reassess q 5min**

Return to:
Tactical Evacuation Guideline

Consider (as LAST Resort): Pressors (Preferred)Vasopressin
4 Unit bolus followed by 0.04U/Min to maintain MAP > 65mmHg

Pearls:

- **All patients requiring DCR should be transferred to the closest facility capable of Damage Control Surgery or REBOA ASAP!!!**
- **Blood Product:** Continue to resuscitate with blood product as available and PRN to achieve/maintain target SBP of > 100mmHg (>110mmHg in patients with TBI/Head Injury). If a unit is transfused in a sending hospital the unit must be delivered to the receiving hospital
- **Hypothermia Management:** Blood fluid warmer use and blankets/HPMK/APLS contribute to effective hypothermia management.
- **Calcium**-30ml of 10% Calcium Gluconate or 10ml of 10% Calcium Chloride, given during or after the first unit of blood product and additionally after every 4 units of blood product during continued resuscitation. Calcium Gluconate preferred over Calcium Chloride (if available). Use extreme caution to avoid extravasation.
- **Calcium**-May be given before TXA due to hypocalcemia and blood product use.
- Optimize hemostasis and correct volume loss first!! Avoid the use of pressors or crystalloids unless absolutely necessary to maintain BP in the absence of blood products and ongoing hemorrhage. Hypertonic saline **SHOULD NOT** be used for treatment of hemorrhagic shock.
- **The use of hydroxyethyl starch (Hextend, Hespan) or Factor VII (rhFVIIa) is NO LONGER RECOMMENDED**
- **Administering TXA < 3 hours from time of injury includes both point of injury and post-operative**

BLOOD COMPONENT / FRESH WHOLE BLOOD USE

IMMEDIATE CLINICAL INDICATIONS in trauma patients with SERIOUS INJURIES and evidence of hemorrhage / shock:

- Systolic blood pressure less than 100 mm Hg or absence of radial pulse
- Tachycardia greater than 100 beats per minute (BPM) or higher
- One or more major amputations

CLINICAL INDICATIONS:

- Uncontrolled hemorrhage or evidence of hemorrhagic shock
    - Trauma patients with amputation (complete or partial with distal circulation compromise)
    - Non-compressible penetrating thoracic, abdominal, and transitional zone injuries (axilla, inguinal, neck)
    - Pelvic Fractures in conjunction with traumatic injury (significant mechanism of injury)
    - Clinical signs of coagulopathy
        - Tachycardia, tachypnea, fever, altered mentation, hypoxemia
    - Severe hypothermia associated with blood loss

CONTRAINIDICATIONS:

- None

PRIOR TO BLOOD PRODUCT TRANSFUSION:

- Maximal hemorrhage control
- Treatment of suspected tension pneumothorax
    - Clinical signs may include: hypotension, hypo-perfusion, diminished or absent breath sounds. Late signs include: tracheal deviation and distended neck veins.
- Patent airway or airway control
- IV/IO access
- Hypothermia prevented and/or treated

ORDER OF PRECEDENCE:

- Resuscitate with Whole Blood
- Plasma, RBCs, Platelets in a 1:1:1 Ratio (no particular order)
- Plasma and RBCs in a 1:1 Ratio
- Plasma (thawed, liquid, reconstituted) alone or RBCs alone

PROCEDURE:

- Document all items on the SF 518 (only authorized document for blood products aboard Army Aeromedical Evacuation platforms).
    - Two person verification of patient and blood products given matching SF 518.
- Observe units of blood
    - Look for gas, discoloration, clots, and sediment
    - Safe-T-Vue must remain white on color indicator. Red coloration indicates that temperature has been exceeded and is no longer acceptable for use.
- Initiate large bore IV (18G min, 14G preferred) or IO access.
    - IO access via sternum or humerus is preferred. Tibia site can be utilized as alternate, but attempt should be made to gain another access point.
    - Lidocaine 2% (2-3 mL) flush in IO sites provides analgesia and increases compliance.
- All blood and blood products will be administered through a dedicated line of NS using Y-tubing with filter.
- Transfuse blood through an approved fluid warming device if available.
- Rapid transfusion can be achieved by using an approved pressure infusion device.
    - Inflate pressure bag to at least 300 mmHg
    - 60 ml syringe or manual pressure can also be utilized in the event a pressure infuser is not available.
- Slow all other concurrent infusions unless they are TXA or RFVIIa.
- Resuscitation Goal:
    - until palpable radial pulse, improved mental status or SBP 100 (SBP >110 w/ head injury) and MAP >60 mmHg.
- Addition of Calcium when administering any amount blood will be given. Citrate binding can adversely affect serum Calcium levels. 30 ml of 10% calcium gluconate or 10 ml of 10% calcium chloride IV/IO should be given to patients in hemorrhagic shock during or immediately after transfusion of the first unit of blood product and with ongoing resuscitation after every 4 units of blood products. Ideally, ionized

calcium should be monitored and calcium should be given for ionized calcium less than 1.2mmol/L.

- Monitor patient every 5 minutes and document any patient signs and symptoms consistent with a transfusion reaction. These include: chills, back/chest pain, rash, fever, hives, and/ or wheezing.

Document procedure, results, and vital signs on the SF 518.

CLINICAL PEARLS AND CONSIDERATIONS:

- Febrile Reaction- Temperature increase (1°C or 2°F) from baseline, chills, flushing, headache and rapid pulse
- Allergic/Anaphylaxis Reaction- itching, chills, flushing, nausea/vomiting, coughing and/or wheezing, or laryngeal edema
  - Treat with Diphenhydramine 50mg IVP or IM. Have Epinephrine standing by.
- Acute Hemolytic Reaction- rapid onset of dyspnea, hypotension, hemoglobinuria, rise in venous pressure, distended neck veins, cough and/or crackles at the bases of the lungs. Treatment is to stop the transfusion, titrate O2 saturations above 94%, and increase IV fluid hydration to 100-200mL/hr to support a urine output above 100-200mL/hr.
- Circulatory Overload- onset of shortness of breath, tachycardia, hypertension, jugular vein distention, pulmonary rates, and hypoxia. This condition may be difficult to distinguish from a hemolytic reaction.
- If a casualty with an altered mental status due to suspected TBI has a weak or absent peripheral pulse, resuscitate as necessary to restore and maintain a normal radial pulse. If BP monitoring is available, maintain a target systolic BP goal of at least 110 mmHg.
- Blood is very viscous, use the largest line available to infuse.

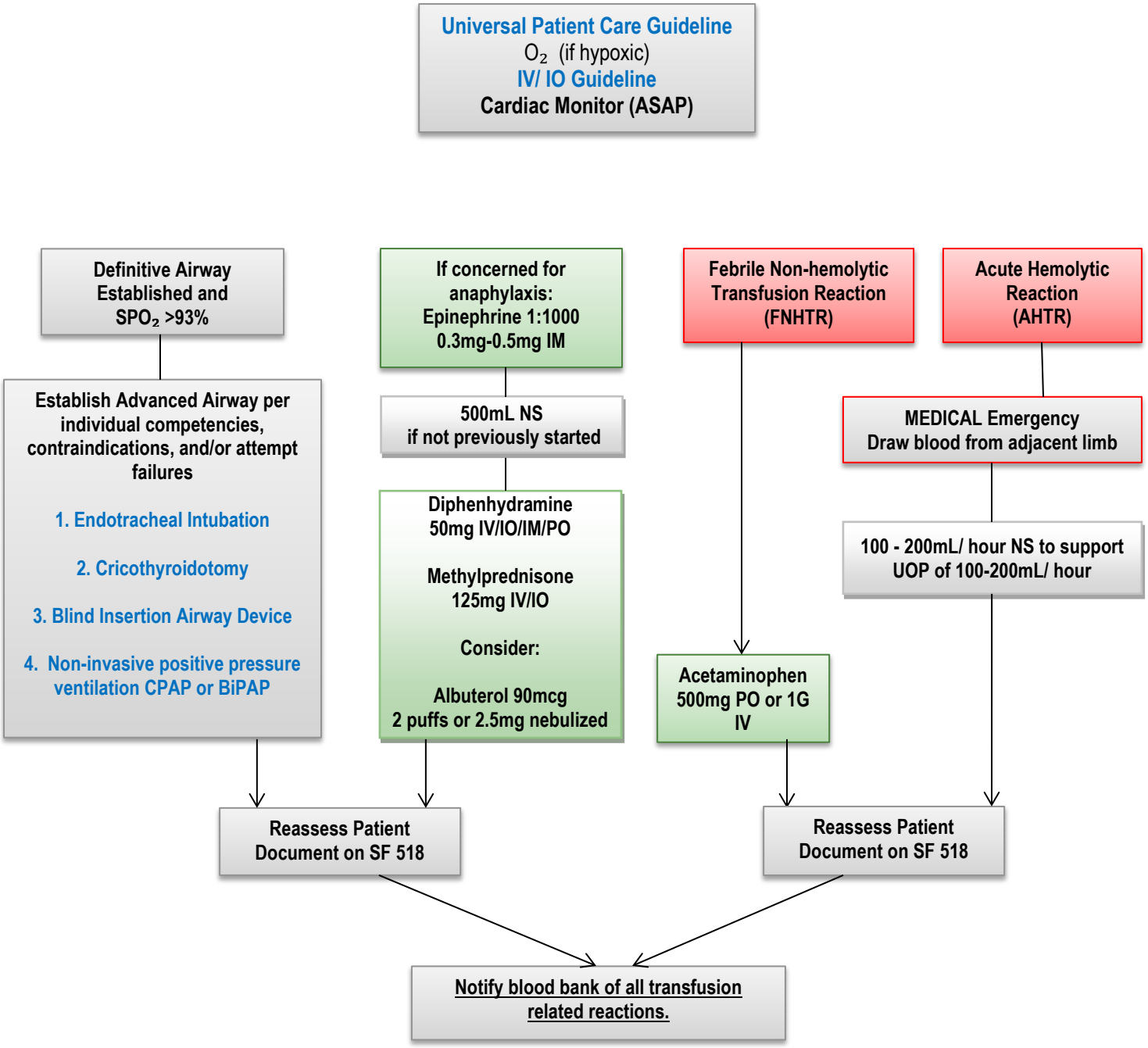
*** Blood component therapy is location specific and is not standard for all missions OCONUS and CONUS.

BLOOD TRANSFUSION RELATED REACTIONS

Differential Diagnosis:	Signs and Symptoms:
Anaphylaxis reaction	Rapid onset of shock, hypotension (<100mmHg systolic), angioedema, and respiratory distress
Acute hemolytic transfusion reaction (AHTR)	Fever (>100.4°F), chills, flank pain, red/brown urine
Febrile non-hemolytic transfusion reaction (FNHTR)	Fever (>100.4°F) or temperature increase of (1°C or 2°F) from baseline, chills, possible dyspnea
Transfusion-related acute lung injury (TRALI)	Hypoxemia (SPO2 <94%), Fever (>100.4°F), hypotension (<100mmHg systolic), cyanosis, tachypnea (>24 breaths per minute), tachycardia (>100 bpm)
Transfusional volume/circulatory overload (TACO)	Dyspnea, orthopnea, tachycardia (>100 bpm), wide pulse pressure, hypertension (>140mmHg systolic), hypoxemia (SPO2 <94%), headache, possible seizure
Mechanical-caused hemolysis	Varies with each device. Fever (>100.4°F), chills, possible dyspnea
Transfusion-transmitted bacterial infection	Fever (>102.2°F or >3.6°F change after transfusion), rigors, tachycardia (>120 bpm or >40 bpm increase following transfusion), rise or fall of systolic blood pressure (>30mmHg)

Pearls:

- GENERAL RULES:
  - Stop the transfusion
  - Keep the intravenous line open with saline
  - Identify and treat cause of the reaction
  - Re-institute the transfusion only if it is deemed to be clinically essential
- Before initiating IVF bolus, ensure IV tubing is new. DO NOT USE existing Y-tubing from blood administration set.
- The most common transfusion reaction is a febrile, non-hemolytic transfusion reaction. These are mostly benign with no lasting sequelae. Treatment consists of antipyretics. (Acetaminophen 500mg PO every 4 hours.)
- TRALI is the leading cause of transfusion-related mortality and commonly occurs is patients who have undergone recent surgery, massive blood transfusion, or who have an active infection. Goal of treatment is supportive and aimed at maintaining oxygenation and reducing respiratory distress.
- TACO is essentially pulmonary edema secondary to congestive heart failure usually occurring in elderly, small children and those with compromised cardiac function. Large volumes of fluid given rapidly are a common precursor to this reaction. Goal is aimed at mobilizing fluids (diuretics) and treating underlying condition. Both TACO and TRALI require immediate resuscitation by an advanced level practitioner.
  - A unit of packed cells should be given at a rate of 2.5-3.0 mL/kg per hour.
- Mechanical-caused hemolysis is commonly caused by rapid transfusion, poor collection and storage, or heating the blood above 42°C during transfusion.


Universal Patient Care Guideline
O_2 (if hypoxic)
IV/ IO Guideline
Cardiac Monitor (ASAP)
Definitive Airway Established and SPO_2 >93%
Establish Advanced Airway per individual competencies, contraindications, and/or attempt failures
1. Endotracheal Intubation
2. Cricothyroidotomy
3. Blind Insertion Airway Device
4. Non-invasive positive pressure ventilation CPAP or BiPAP
If concerned for anaphylaxis: Epinephrine 1:1000 0.3mg-0.5mg IM
500mL NS if not previously started
Diphenhydramine 50mg IV/IO/IM/PO
Methylprednisone 125mg IV/IO
Consider:
Albuterol 90mcg 2 puffs or 2.5mg nebulized
Febrile Non-hemolytic Transfusion Reaction (FNHTR)
Acetaminophen 500mg PO or 1G IV
Acute Hemolytic Reaction (AHTR)
MEDICAL Emergency Draw blood from adjacent limb
100 - 200mL/ hour NS to support UOP of 100-200mL/ hour
Reassess Patient Document on SF 518
Reassess Patient Document on SF 518
Notify blood bank of all transfusion related reactions.

Pearls:

- Blood transfusions conducted during point of injury for casualties suffering from blood loss/massive hemorrhage may not show any transfusion reaction during the limited transport time.

BLOOD GLUCOSE ANALYSIS

CLINICAL INDICATIONS:

- Suspicion of blood glucose abnormalities – hyperglycemia/hypoglycemia.

CONTRAINDICATIONS:

- None

PROCEDURE:

- Gather and prepare equipment.
- Obtain blood samples for analysis as per manufacturer's recommendations.
- Place blood sample onto reagent strip and place into machine for analysis as per manufacturer recommendations.
- Record result and treat any glucose abnormalities per appropriate guideline.
- Perform quality assurance on glucometers weekly. If any suspicious recordings are noted, follow manufacturer's recommendations

Document procedure, results, and vital signs.

Invasive Pressure Monitoring

Purpose:

MEDEVAC Crews are required to monitor invasive pressure on any patient with central venous or arterial access.

Procedure:

- If the referring facility's transducer unit is not compatible with transport unit's cable, replace with compatible transducer setup using aseptic technique.
- Ensure IV pressure bag is preset and inflated to 300mmHg with stopcock closed
- Place transducer at phlebostatic axis and secure with tape
- Zero the line to obtain a "zeroed" reading on the transport monitor
- Flush the line and perform a square waveform test
    - Evaluate the waveform and numeric values for correlation with recent patient trends

Notes:

- Evaluate the insertion site for bleeding, swelling, hematoma, or dislodgement
- Tightly secure stopcocks and cover openings with non-vented endcaps
- Continue monitoring correlation between NIBP and ABP
- Zero the line after movement of patient, at altitude, and if suspected erroneous reading
    - Adjust/re-calibrate monitor every 1000' if required based upon monitoring device
- If waveform dampened, check pressure bag inflation and reassess position of leg/wrist
- If invasive line is in the femoral artery, keep patient head <30° and leg straight. Reassess distal pulses with any patient movement
- Flush line and evaluate square waveform test as needed
- If invasive line becomes dislodged, immediately apply direct pressure

REBOA MANAGEMENT

Purpose:

Surgical Team or SOF Medic placement for trauma arrest or non-compressible hemorrhage in the pelvis. Secondary to emergency thoracotomy or external junctional tourniquets.

Procedure:

- Receive report from team that placed device.
  - Who inserted the device?
  - What type of device (ER-REBOA)?
  - Where located (Zone 1 or Zone 3)? How confirmed? (xray, ultrasound)
  - When was the balloon inflated?
  - Why was it placed (Arrest? Peri-arrest? Pelvic bleed?)
  - How is the device secured?

- Confirm vital sign trends with sending team
- Confirm security of REBOA device with sutures, commercial securing device, or tape.
- Record the length measurement at insertion site.
- Confirm balloon pressure.
- Check distal circulation and any external hemorrhage (Doppler)
- Connect Arterial line to hemodynamic monitoring device.
- Verbalize plan to move patient to next level of care. Ensure time of balloon inflation.
- Continue to closely monitor until patient is secured in the next level of care (Hemodynamic monitoring, distal circulation, device security, catheter depth)

CONCERNS:

- Changes in altitude
- Transient drop in blood pressure
- Change in balloon pressure
- Dislodge of device
- Loss of distal circulation
- Distal external hemorrhage

CARDIAC DEFIBRILLATION

CLINICAL INDICATIONS:

- Patient who is in pulseless cardiac arrest with either ventricular fibrillation or ventricular tachycardia seen on monitor.

CONTRAINDICATIONS:

- None

PROCEDURE:

- Ensure patient attached to monitor / defibrillator. If paddles used, ensure that they are several centimeters away from monitor leads to prevent arcing. Use pediatric paddles as indicated – if unavailable and pads used, should place in anterior / posterior position for pediatric patients.
- Set energy level to appropriate level. Start 200J adult (biphasic) or 360J adult (monophasic), or 2J/kg pediatric.
- Press "charge" button 30 seconds prior to end of compressions. This maneuver minimizes time between compressions and defibrillation. Compressions should continue until end of cycle.
- Ensure all personnel clear of patient and pilots aware of cardioversion.
- Press and hold "shock" button until energy delivered.
- If rhythm converts – treat as per post resuscitation protocol.
- Following shock delivery, immediately begin / return to CPR for 2 minutes before checking for pulse.
- If pediatric patient fails to convert – repeat steps 2-7 above using escalating energy levels.
- **Document procedure, results, and vital signs on run sheet following mission.**

AUTOMATED EXTERNAL DEFIBRILLATOR (AED):

- Turn on power to machine and follow prompts to attach pads to patient and machine.
- Ensure no one touching / moving patient and press the "Analyze" or equivalent button. (If not present, the machine will automatically check the rhythm at dedicated time intervals. A vocal warning will tell you when this is occurring).
- If shock advised, press button to deliver shock and return to CPR for 2 minutes.
- After analysis, if subsequent shocks advised, repeat steps 2-3 up to 3 shocks, until further care arrives, or until no further shock advised. **If no shock advised at any time, CHECK PULSE**. Continue CPR if no pulse. If pulse present, place patient in recovery position and transport.

12-LEAD ELECTROCARDIOGRAM

CLINICAL INDICATIONS:

- Suspicion of arrhythmia.
- Chest pain believed to be of cardiac origin.
- Toxic ingestion with cardiac side effects.

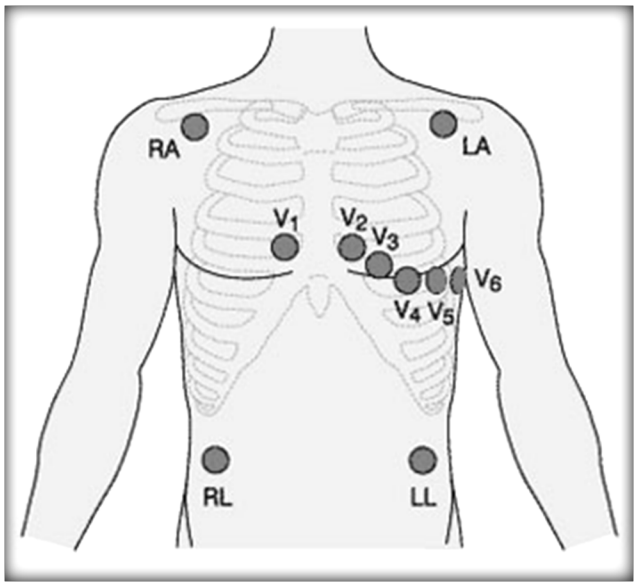
CONTRAINDICATIONS:

- None

PROCEDURE:

- Ensure patient lying flat on bed and place leads as per diagram.
- If patient is unstable, address any emergent issues prior to attempting the 12-lead EKG.
- May have to shave and/or dry patient for pad adhesion.
- Once leads are in place, instruct the patient to remain still and limit any movements around the patient (as possible).
- Press button to obtain 12-lead EKG.
- If questions exist, maintain supportive care and contact medical control if able.

Document procedure, results, and vital signs.



SYNCHRONIZED CARDIOVERSION

CLINICAL INDICATIONS:

- Unstable patient with tachycardia-dysrhythmia noted on monitor/EKG.
- Patient who has failed conservative and/or chemical cardioversion.
- Patient not pulseless.

CONTRAINDICATIONS:

- None

PROCEDURE:

- Ensure patient attached to monitor/defibrillator with synchronized cardioversion capability.
- Time-permitting, ensure adequate IV / IO access present. Ensure that unsynchronized cardioversion/defibrillation capabilities present in case patient degenerates into another dysrhythmia.
- Consider use of sedating medication (e.g., Midazolam 0.1mg/kg (5mg max dose) prior to delivery of shock. **Note: This step is not mandatory and should not delay appropriate management of emergent condition.**
- Set energy level to appropriate level. Usually starting at 50J-100J in adults or 0.5J/kg-1J/kg in children for atrial/ventricular arrhythmias, respectively.
- Select **Synchronized Cardioversion** option. This should result in machine displaying **"SYNC"** as well as tracking electrical activity (arrow or highlighted segment of EKG).
- Ensure all personnel clear of patient and pilots aware of cardioversion.
- Press and hold "Shock" button until energy delivered. (This may take several seconds for machine to synchronize with cardiac cycle. Shock is not immediately delivered as in defibrillation.)
- If rhythm converts – monitor and treat as appropriate.
- If fails to convert – repeat steps 4-7 above using escalating energy levels. If patient degenerates, treat as per appropriate protocol/CPR. **Note: most machines require pushing the "SYNC" after each shock if synchronized cardioversion to be repeated, failure to do so will result in delivery of an unsynchronized shock.**
- **Document procedure, results, and vital signs on run sheet following mission.**

TRANSCUTANEOUS (EXTERNAL) CARDIAC PACING

CLINICAL INDICATIONS:

- Patients with pulse rate <60 (or appropriate for age) and signs of inadequate cerebral or end-organ perfusion.

CONTRAINDICATIONS:

- None

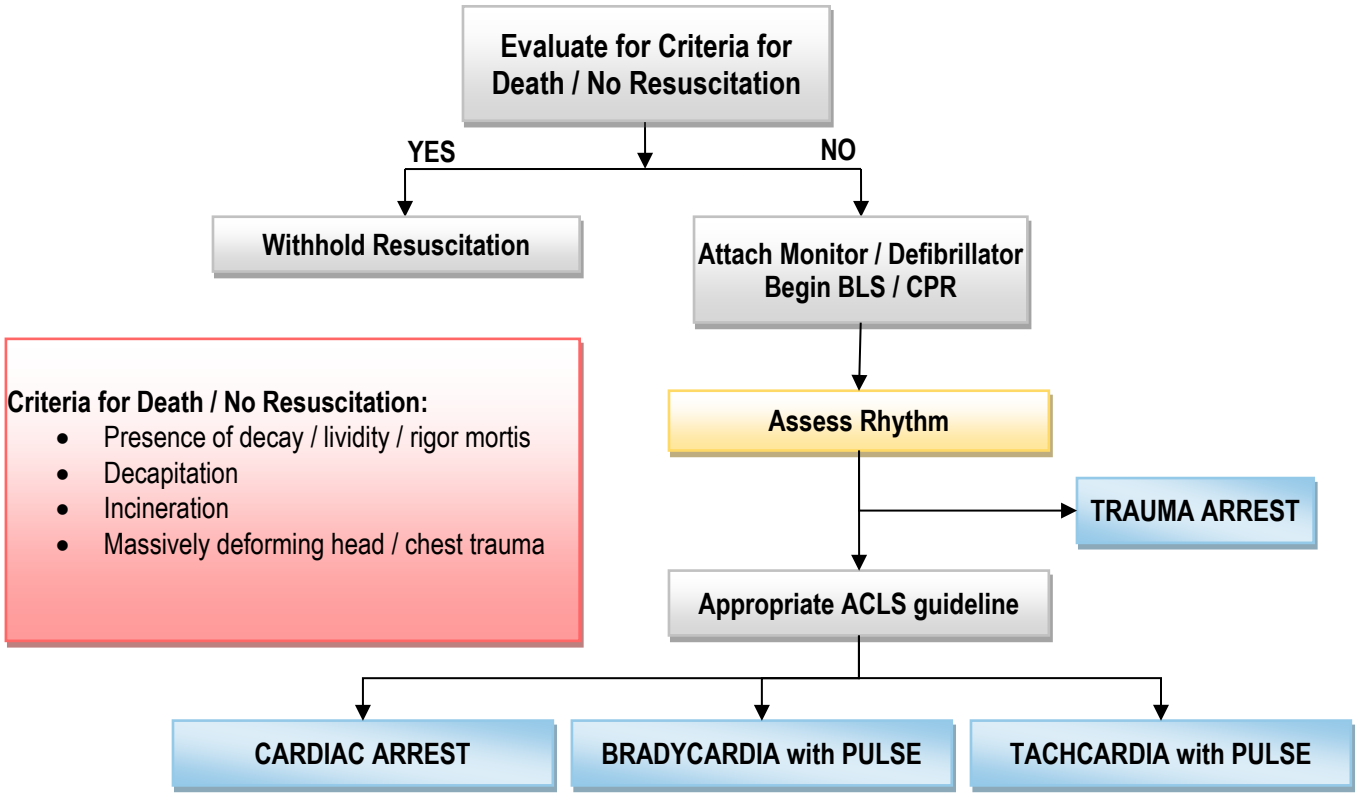
PROCEDURE:

- Ensure patient attached to monitor and defibrillator with external cardiac pacing capabilities.
- Time-permitting, ensure adequate IV/IO access prior to pacing. Also, may administer sedative agent (midazolam) prior to beginning pacing.
- Turn selector switch to "Pace."
- Set rate to twice the patients intrinsic rate (often 70-80 for adult, 100 for pediatric).
- Set energy level to lowest setting and gradually increase until capture is obtained (each pacer spike followed by QRS).
- Once capture obtained, ensure pulse and vital signs correspond with pacing. Evaluate patient for improvement. Monitor and continue sedation as needed.
- If fails to capture at maximal setting, discontinue pacer.
- At any time, if patient degenerates and needs CPR – begin compressions immediately. Pacer pads are insulated and it is okay to perform compressions with pacer running.
- **Document procedure, results, and vital signs on run sheet following mission.**

WITHHOLD RESUSCITATION

Signs and Symptoms:
- **Unresponsive**
- **Apneic**
- **Pulseless**

Differential Diagnosis:
- **Medical vs. Traumatic Arrest**
- **Dysrhythmia**



Pearls:
- As with all ALS protocols – **concentrate on adequate compressions**.
- Minimize interruptions in compressions, including if/when placing advanced airway.
- Early defibrillation associated with greatest success in early cardiac arrest.
- Survival rate for traumatic arrest approaches zero.
- Cardiac arrest in MASCAL situations requires frequent re-triage to apply care where it will be most effective.
- Lack of response alone does not equal death – always check for pulse / cardiac activity.
  - If available, cardiac US can be helpful in determining if continued efforts will be helpful. If there are no signs of cardiac movement on US and there is no other known reversible cause, the likelihood of ROSC and recovery with continued resuscitative efforts in the out-of-hospital setting is incredibly unlikely.

ALTITUDE PHYSIOLOGY AND PATIENT TRANSFER

ALTITUDE CONCERNS FOR AEROMEDICAL TRANSFERS:

- **Gas expansion** occurs as altitude above sea level increases. Gas volume doubles at 18,000' mean sea level (½ sea level atmospheric pressure) and increases 25% from 5,000'-10,000'. This will typically not affect the operational ceiling for the UH-60 Blackhawk during Aeromedical Evacuation operations. Certain conditions and precautions to note:
  - ✓ **Air embolism / Decompression illness** – This is the only absolute contraindication to transport of patients at altitude. These patients should be transferred at sea level or in an A/C capable of cabin pressurization to sea level.
  - ✓ **Pneumothorax** – There is little risk of developing a tension PTX due to gas expansion from altitude during typical aeromedical evacuation flights in rotary-wing A/C. However, altitude should be limited when possible to <5,000' MSL. If mission requirements mandate higher altitudes, the use of aeromedical evacuation platforms with pressurized cabins should be considered as applicable and tactically capable. Prophylactic chest tubes (for altitude-related concerns) are recommended for any flights above 10,000' mean sea level.
  - ✓ **Gastric distention** – Gas expansion does increase the risk of vomiting and, therefore, aspiration. Therefore, all patients with decreased LOC should have an NG / OG tube placed prior to transfer.
  - ✓ **Head injury** – As with PTX, there is little concern of altitude related elevation of elevated ICP in head injured patients although penetrating intracranial or maxillofacial injuries may set conditions for an entrapped-gas phenomenon with adverse clinical consequences. Any evidence of elevated ICP should result in treatment per guideline. Altitude restrictions do not differ from those listed for PTX. Constant vigilance should be maintained for evidence of elevation of ICP.
  - ✓ **Eye injury** – Penetrating eye injuries or surgeries may introduce air into the globe. Again, the altitudes obtained for rotary-wing A/C does not pose a risk of elevating the IOP during normal operations.
  - ✓ **Gas filled equipment** – Medical equipment with gas filled bladders also may suffer from interference at high-altitudes. Primarily, endotracheal tube cuffs and pressure bags which should be evaluated at altitude by testing the pressure of the exterior bladder or filled with air. If able, utilize manometer to

verify tube pressure. A cuff pressure between 20-30 cmH2O is recommended to provide adequate seal and reduce the risk of complications or tissue damage. Verify with supervising physician or flight surgeon before filling endotracheal tube with saline. Routine filling of endotracheal tubes with saline is no longer recommended.

- **Flow Rates:** Decreased atmospheric pressure may interfere with IV flow rates and/or pump function. These must be monitored continuously.
- **Invasive Blood Pressure:** Adjust / re-calibrate monitor every 1000' if required based upon monitoring device.
- **Hypothermia:** As altitude increases, the temperature will drop about 3.5° F per 1000 feet. This is further complicated in the H-60 due to rotor-wash, forward air speed, normal lapse rate. Therefore, patients must be protected from hypothermia at all times. This includes use of the Hypothermia Prevention and Management Kit (HPMK), blankets, heaters if available, and closing cabin doors / crew windows during transport.
- **Hypoxia:** Patients are at increased risk of hypoxia during transport at altitude. If transfers are taking place in high-altitude locations, pulse oxygenation should be monitored at all times and the medic / provider should maintain a low threshold for the use of supplemental O_2. At no time should the patient's O_2 be allowed to go below 92 percent (commercial pulse oximeters read up to 3 percent off, therefore a sat of 91 percent may be seen in a patient who is really at 88 percent.). ***Patients who smoke or have underlying cardiopulmonary disease are at increased risk even at low altitudes.***
- **Dysbarism:** Patients may experience discomfort due to gas expansion in air-filled body spaces (e.g., ears, sinuses, teeth) during ascent. Conversely, patients and aircrew may experience "squeeze" resulting from descent from altitude. These are typically mild during RW transport, however, if severe, altitude should be held and attempts made to alleviate pain and/or slow rate of ascent / descent.

Document procedure, results, and vital signs.

POST-OPERATIVE & CC INTERFACILITY TRANSFER

CLINICAL INDICATIONS:

- Patient at outlying MTF requiring transfer to higher role of care for more definitive surgery/treatment

PRE-TRANSFER Patient Status Requirements:

a. JTS CPG – Intra-theater Transfer and Transport – recommends clinical parameters that should be met prior to transfer; if parameters are not met, they should be addressed and en-route mitigation plans formulated BEFORE departure / transfer:
   1) Heart rate 50><120 bpm
   2) SBP >90 mmHg, MAP >60mmHg
   3) If elevated ICP or CPP, maintain MAP 80><110mmHg, SBP 110><160mmHg
   4) Hematocrit >24% (or Hgb >8g/dL)
   5) Platelet count >50/mm^3
   6) INR <2.0
   7) pH >7.3
   8) Base deficit <5mEq/L
   9) Temperature >35.5^{0}C or 96^{0}F
   10) $ETCO_2$ 35><45, SPO_2 ≥92%, and/or $PaCO_2$ 35><45mmHg

If these criteria are not met, the transferring physician should continue resuscitation or provide documentation indicating limitations that compel urgent transfer. This can be documented in the comments section of the **Standard Order Set for Critical Care Transfers** document.

b. The four *MINIMUM* requirements which will be met prior to patient transfer are hemorrhage control, adequate shock resuscitation (SBP 90 mmHg, MAP >60 mmHg, UOP >0.5 mL/kg/hr, and/or BD <2, Temp >97^{0}F and <100^{0}F), stabilization of fractures, and initial post-operative recovery.
c. Attempt to keep patient packaging time at <25 minutes; use of warming devices in accordance with the JTS Hypothermia Prevention CPG.
d. Movement of Deceased Patients:
   1) In general, patients who meet clinical criteria for death are not to be transported by MEDEVAC, with the exception of extreme extenuating circumstances, such as emergency exfiltration during CSAR.
   2) If vital signs are absent prior to launch, make all reasonable attempts to resuscitate as clinical and tactical circumstances permit. If unsuccessful, consider basic cardiac ultrasound (as available) to determine whether any signs of cardiac activity are present. If absent, mission abort is warranted.

3) In such circumstances, contact and consultation with medical control or other available physician is suggested, in order to facilitate field determination of death and cessation of resuscitative efforts.

PROCEDURE:

a. **Role 2/3 provider responsibilities:**

It is the **responsibility of the transferring physician to write enroute care orders** appropriate for the transport environment and individualized for each patient in consultation with the Critical Care Flight Paramedic and/or the ECCN (or attending Flight Provider) prior to launch. The Flight Paramedic / Provider should be given a **Standard Order Set for Critical Care Transfers** or similar document with en route care orders signed by the transferring physician.

1) Provide a complete report to Flight Paramedic / Provider.
2) Provide all patient-specific related medical records.
3) Assist Flight Paramedic / Provider with packaging patient for transport as requested.
4) Complete specified areas on the appropriate patient care report
   i. Administrative data
   ii. Most current laboratory data
   iii. Mechanism of Injury (MOI)
   iv. Diagnosis
   v. Procedures
5) Place patient on ventilator at least 30 minutes prior to flight. Obtain pre-flight ABG to ensure patient tolerates ventilator settings.
6) It is strongly suggested that the transferring physician make every possible attempt to contact and discuss the case with the receiving physician or facility representative. Flight Paramedics and ECCNs should confirm or encourage this vital "physician-to-physician hand-off" if practicable.

b. **FLIGHT PARAMEDIC / PROVIDER responsibilities prior to transfer**:

1) Obtain orders for en route care from transferring physician; review orders and discuss potential en route problems with transferring physician, reconcile medications (ensure needed medications, specific to patient's condition, are obtained and prepared), allergies and patient's weight, confirm patient's identification, and secure personal effects.
2) Perform primary & secondary assessment ensuring an understanding of the patient's injuries / illness / procedures performed.
3) Spinal immobilization is indicated during transfer if ordered by transferring physician.
4) Assess placement and secure all tubes, lines, and drains & ensure proper functioning.
5) Ensure endotracheal tube is secure; secure pulse oximeter / $ETCO_2$ monitor.

6) Review ABG – ABG should be done within 30 minutes of flight; patient should be on transport ventilator with vent settings for transport; ABG obtained 15 minutes after being placed on transport ventilator.
7) Ensure vascular access X 2 - peripheral, central or IO and A-line as needed.
8) Check all bandages, splints, dressing, fixation devices and tourniquets for placement and ensure no evidence of ongoing hemorrhage.
9) If indicated, insert OG/NG tube for gastric decompression, especially in intubated patients; cap or place to suction.
10) Empty Foley catheter bag prior to flight; ensure UOP documentation by transferring facility.
11) For an intubated patient, provide adequate analgesia and sedation PRIOR to giving additional paralytic medications. Re-dose medications as needed prior to flight in accordance with transferring physician's orders.
12) Continue administration of blood products if ordered by transferring physician. If anticipated administration of blood products enroute, Flight Paramedic/Provider should request orders for blood products and appropriate blood products from the transferring physician and use FDA approved fluid warming device as appropriate for warming fluids.
13) Collect all patient care documentation for transport with patient, i.e. pre-hospital, transport, labs, x-rays, transferring facility notes, etc.
14) Remove all air from IV fluid bags and place all free flowing bags in pressure bags.
15) Ensure patient is properly packaged in a warming device unless contraindicated prior to transfer. Follow directions specific to each warming device ensuring over heating or thermal burns do not occur. Hypothermia, acidosis and coagulopathy constitute the "triad of death" in trauma patients.
16) Securely affix all equipment, supplies, loose tubing and lines to NATO litter prior to moving the patient to the vehicle or aircraft.
17) Once patient is packaged, ensure all lines are leveled and monitors are zeroed.
18) Provide eye and ear protection to patient.

c. Special considerations:

1) Eye Trauma: Fox shields should be placed for any patient with a suspected or confirmed open globe, possible intraocular foreign body or eye injury. **DO NOT remove impaled or stubborn foreign bodies from the eyes.** (even contact lens**) SHIELD AND SHIP. DO NOT PLACE ANY DRESSINGS UNDER RIGID EYE SHIELD** or manipulate the injured eye. Both the injured and uninjured eye should be covered IOT avoid excessive movement of the injured eye which may result from involuntary convergence. Also want to avoid nausea/vomiting in these patients. Normal Saline may be used to rinse eyes in awake patient with no penetrating injury. (JTTS CPG - Initial Care of Ocular & Adnexal Injuries)
2) Compartment Syndrome: Patients with extremity injuries, abdominal injuries/surgery, burns, coagulopathy and those who have received massive transfusion are at risk for compartment syndrome. Ensure proper assessment prior

to flight. If compartment syndrome is suspected during flight, place extremity at the level of the heart. Pain out of proportion to the injury and paresthesia are symptoms of compartment syndrome, as well as pallor, paralysis, pulselessness, and poikilothermia. Patients who are sedated, paralyzed or have an epidural or block in place are at increased risk and require judicious hands on assessment of at risk abdomen and extremities. (JTTS CPG – Compartment Syndrome and Fasciotomy)

3) Burns: For patients with partial and/or full-thickness burns to > 20% TBSA, use of the Burn Patient Admission Orders and **JTTS Burn Resuscitation Flow Sheet** are REQUIRED and should be continued during transfer to another facility. (JTTS CPG – Burn)
4) Advanced pain management modalities: For patients with epidurals, continuous peripheral nerve blocks, PCA infusions, or other pain medicine infusions, a pain note should be completed prior to transport as it is a vital part of provider communication. (JTTS CPG – Management of Pain, Anxiety and Delirium in Injured Warfighters)
5) Sedation and pain management must be maintained at appropriate levels throughout transport. As appropriate and as directed by transferring physician, attempt to maintain sedation target as follows using the Riker Sedation-Agitation Scale (SAS)

Riker Sedation-Agitation Scale (SAS): Used as sedation target goal for Post Surgical / CC

- Non-intubated patients, provide sedation as needed to maintain a goal SAS Score of 3-4.
- Intubated patients, provided sedation as needed to maintain a goal SAS Score of 1-2.

		Definition
7	Dangerous agitation	Pulling at endotracheal tube, trying to remove catheters, climbing over bedrail, striking at staff, thrashing from side-to-side
6	Very agitated	Does not calm despite frequent verbal reminding of limits, requires physical restraints, biting endotracheal tube
5	Agitated	Anxious or physically agitated, attempting to sit up, calms down on verbal instructions
4	Calm, cooperative	Calm, arousals easily, follows commands
3	Sedated	Difficult to arouse, awakens to verbal stimuli or gentle shaking but drifts off again, follows simple commands
2	Very sedated	Arouses to physical stimuli but does not communicate or follow commands, may move spontaneously
1	Unarousable	Minimal or no response to noxious stimuli, does not communicate or follow commands

ECC Nurse Protocols May 2012

d. Patient Care Enroute to the Receiving Hospital

1) Patient vital signs will be monitored continuously enroute and documented at least every 5 – 15 minutes (q5min if on pressors) per transferring physician's orders.
2) Reassess patient at least every 15 minutes and address events as necessary following transferring physician's orders and protocols for the specific illness or injury.

3) Assess pain control, sedation and need for paralysis. Re-dose medications as needed in accordance with transferring physician's orders. Ideally, paralytic medication should not be administered near the end of the flight. Significant, adjunctive analgesia may be required to compensate for initial lift, landing and in flight combat maneuvers, therefore Flight Paramedic/Provider should consider carrying higher volumes of analgesia that would be normally used in ground transport or fixed facilities.
4) All events will be addressed with appropriate interventions according to transferring physician's orders and protocols. All interventions require reassessment for patient response to the intervention.
5) All enroute care, including ventilator changes, medications, events, interventions, and patient's response will be documented on the appropriate patient care documentation.

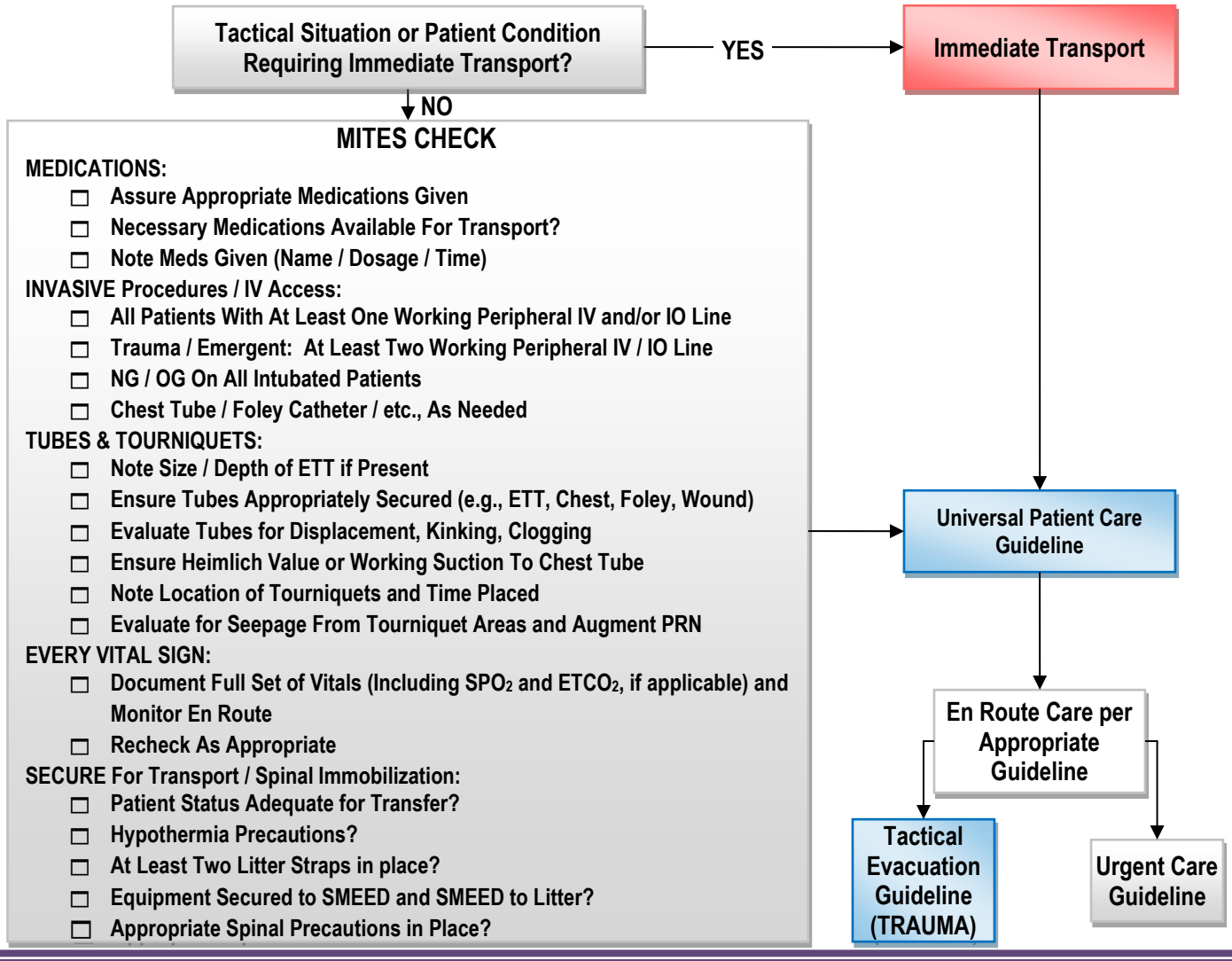
e. Patient Report and Transfer of Care at the Receiving Hospital

1) A verbal and written patient report will be given to the receiving nurse or physician upon delivery of the patient.
2) Routinely, the responsibility of care will be transferred at the receiving ED. On rare occasions (i.e. mass casualty incidents, pending emergency flights, etc.), care may need to be transferred on the helipad rather than at the bedside.
3) For Tail-to-Tail transfers, the Flight Paramedic/Provider initiating transport will send all documentation from the transferring facility and the patient care documentation from the first leg of the flight with the Flight Paramedic/Provider completing the second leg of the transfer. The Flight Paramedic/Provider completing the second leg of the transfer will initiate their own patient care documentation, circling "2nd Leg" at the top of the form and ensure all documentation is turned over to the MTF upon arrival and hand off of patient care.
4) The patient care documentation will be completed and left with the patient at the receiving facility at the time of patient handover. If unable to complete documentation due to extensive mission requirements, the patient care documentation will be forwarded to the appropriate medical information receiving facility/person IAW local / theater policy.

Any in-flight problems should be addressed per appropriate protocol and per written instruction from transferring physician. Continued problems should prompt contacting medical control as soon as it is possible.

Document procedure, results, and vital signs.

PRE-TRANSPORT CHECKLIST


Tactical Situation or Patient Condition Requiring Immediate Transport?
YES
Immediate Transport
NO
MITES CHECK
MEDICATIONS:
☐ Assure Appropriate Medications Given
☐ Necessary Medications Available For Transport?
☐ Note Meds Given (Name / Dosage / Time)
INVASIVE Procedures / IV Access:
☐ All Patients With At Least One Working Peripheral IV and/or IO Line
☐ Trauma / Emergent: At Least Two Working Peripheral IV / IO Line
☐ NG / OG On All Intubated Patients
☐ Chest Tube / Foley Catheter / etc., As Needed
TUBES & TOURNIQUETS:
☐ Note Size / Depth of ETT if Present
☐ Ensure Tubes Appropriately Secured (e.g., ETT, Chest, Foley, Wound)
☐ Evaluate Tubes for Displacement, Kinking, Clogging
☐ Ensure Heimlich Value or Working Suction To Chest Tube
☐ Note Location of Tourniquets and Time Placed
☐ Evaluate for Seepage From Tourniquet Areas and Augment PRN
EVERY VITAL SIGN:
☐ Document Full Set of Vitals (Including SPO2 and ETCO2, if applicable) and Monitor En Route
☐ Recheck As Appropriate
SECURE For Transport / Spinal Immobilization:
☐ Patient Status Adequate for Transfer?
☐ Hypothermia Precautions?
☐ At Least Two Litter Straps in place?
☐ Equipment Secured to SMEED and SMEED to Litter?
☐ Appropriate Spinal Precautions in Place?
Universal Patient Care Guideline
En Route Care per Appropriate Guideline
Tactical Evacuation Guideline (TRAUMA)
Urgent Care Guideline

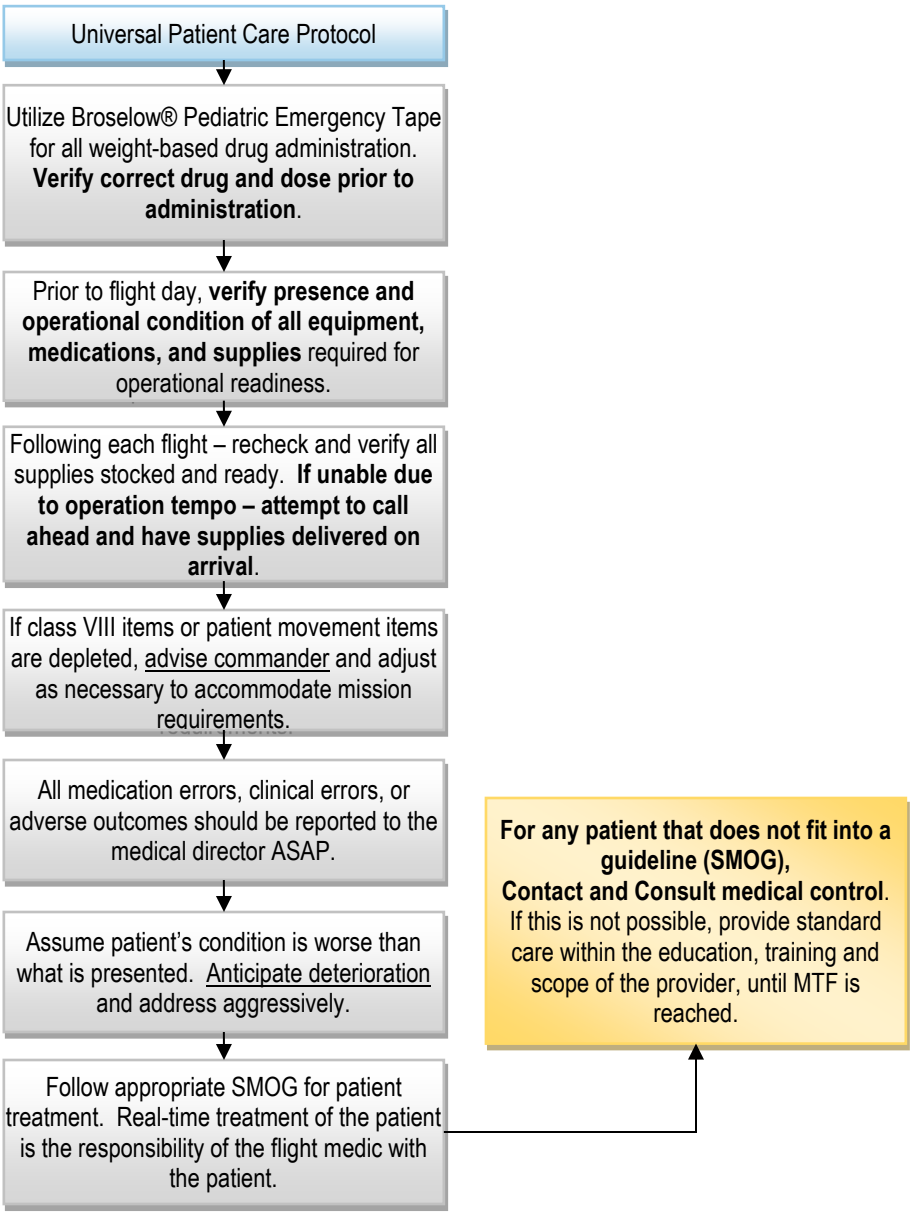
PEARLS:

- Any patient with advanced airway and ventilator support should receive sedation and, if indicated, paralytic agent before flight. These should be available in the aircraft for use by *qualified personnel* for use if patient becomes conscious, agitated, combative, etc.
- Spinal immobilization should be ensured in all blunt trauma (e.g., MVA, fall, blast, combination trauma) where spinal instability may be suspected. The medic should document if spinal injuries are cleared and who cleared them.
- A minimum of two IV / IO sites in patients with emergent or emerging conditions. At least one should be present in all patients transported by MEDEVAC for any other causes. Rare exceptions may exist (e.g., minor musculoskeletal injury).
- All critical care patients should have continuous cardiac monitoring while in en route. This may also extend to non-intubated urgent / priority patients under other circumstances (e.g., acute MI, atypical chest pain).
- **Tactical situation and emergent care should take priority over all other procedures / monitoring.** If unable to perform checks and/or procedures during flight due to the Tactical / Environmental Conditions (e.g., enemy, weather) then this must be documented completely in the Patient Care Report and briefed-back to the receiving medical facility. Continue with monitoring and procedures as soon as situation allows.

DO NOW	TAKE WITH	INFLIGHT
M: ☐ Check all bandages, splints, dressings and tourniquets for placement / evidence of ongoing hemorrhage. ☐ Mark bleeding strikethrough ☐ Measurement of abdomen ☐ Request orders for type and cross-matched blood or O-negative blood from the transferring physician.	**M:** ☐ Additional Blood products (1:1:1) ☐ Tubing ☐ Warmer ☐ Golden Hour Container	**M:** ☐ Blood products administration ☐ Check all bandages, splints, dressings and tourniquets for placement / evidence of ongoing hemorrhage ☐ Measurement of abdomen.
A: ☐ Assess and document ET tube size, depth, security, cuff pressure, bite block ☐ Attach ETCO2 monitor ☐ Insert/Assess and document NG/OG tube placement, size, depth, security ☐ Review chest radiograph for ET confirmation and NG/OG placement ☐ Apply C-collar for airway stability	**A:** ☐ Extra ETT / King LT / IGEL ☐ Suction soft-tip ☐ 10ml syringe ☐ Bite block ☐ Tape ☐ BVM	**A:** ☐ Confirm ETT is in appropriate position ☐ Look/feel for symmetric chest wall rise ☐ Verify tube position at teeth ☐ Check ETCO2 ☐ DOPE
R: ☐ Setup Ventilator and confirm ventilator settings ☐ Check baseline lung compliance/resistance with BVM ☐ Auscultate heart/lung sounds ☐ Check placement and function of chest tube/drainage system/ Heimlich valve. ☐ Request arterial blood gas after transport ventilator is attached to patient	**R:** ☐ O2 for transport ☐ Backup ventilator ☐ Suction ☐ Needle for decompression	**R:** ☐ Look and feel for chest excursion ☐ Check Pulse Ox ☐ Check patient's color
C: ☐ Setup Monitor and zero all Pressure Lines ☐ Assess distal pulses and neurovascular status ☐ Ensure IV access x 2 (Minimum). ☐ Remove air from IV bags and pressurize ☐ IV medications arranged for easy access (20ml, 10ml, 5ml, 3ml) ☐ Review CBC/Chemistry results ☐ Check Foley catheter placement, measure output amount, empty bag	**C:** ☐ Vasoactive medications (dopamine, neo, norepinephrine) ☐ Pressure bags ☐ IV fluids and tubing	**C:** ☐ Check temp, pulse BP, and cardiac rhythm ☐ Assess distal pulses and neurovascular status during transport. ☐ Assess IV access ☐ LZC Pressure Lines
H/I: ☐ Conduct baseline neurologic exam ☐ Provide eye and ear protection to patient; HPMK, warmed IV fluids, blankets and/or chemical heat packs. ☐ Review orders and discuss potential en-route problems with the transferring physician. ☐ Ensure patient and all equipment secured ☐ Place transport ventilator on transport O2 ☐ Assess pain control, sedation and need for paralysis. Re-dose medications if needed before flight ☐ Patient loading considerations	**H/I:** ☐ Collect all labs, x-rays, pre aid-station/hospital documentation for transport ☐ Reconcile medications; verify allergies and patient's weight ☐ Secure personal effects. ☐ Sedation meds (propofol, versed, ketamine) ☐ Pain meds (fentanyl, morphine, ketamine) ☐ Paralytic meds (vecuronium, rocuronium) ☐ 3% NaCl,	**H/I:** ☐ Assess neurologic and sedation ☐ Check placement of all tubes, lines and drains & ensure proper functioning ☐ Ensure all wires and tubing are accessible and have adequate slack to allow monitors and IVs to be properly positioned and secured ☐ Serial assessments ☐ Prepare patient and give report to receiving facility

Altitude Considerations	Medications	Patient Packaging
Required waiting time before transport	Type and number of patients	Additional Medical support/non-medical attendant
Respiratory Support	Monitoring (body systems, medical interventions, etc.)	Telephonic consultation
Equipment	Thermal considerations	Transport time and Route of transfer

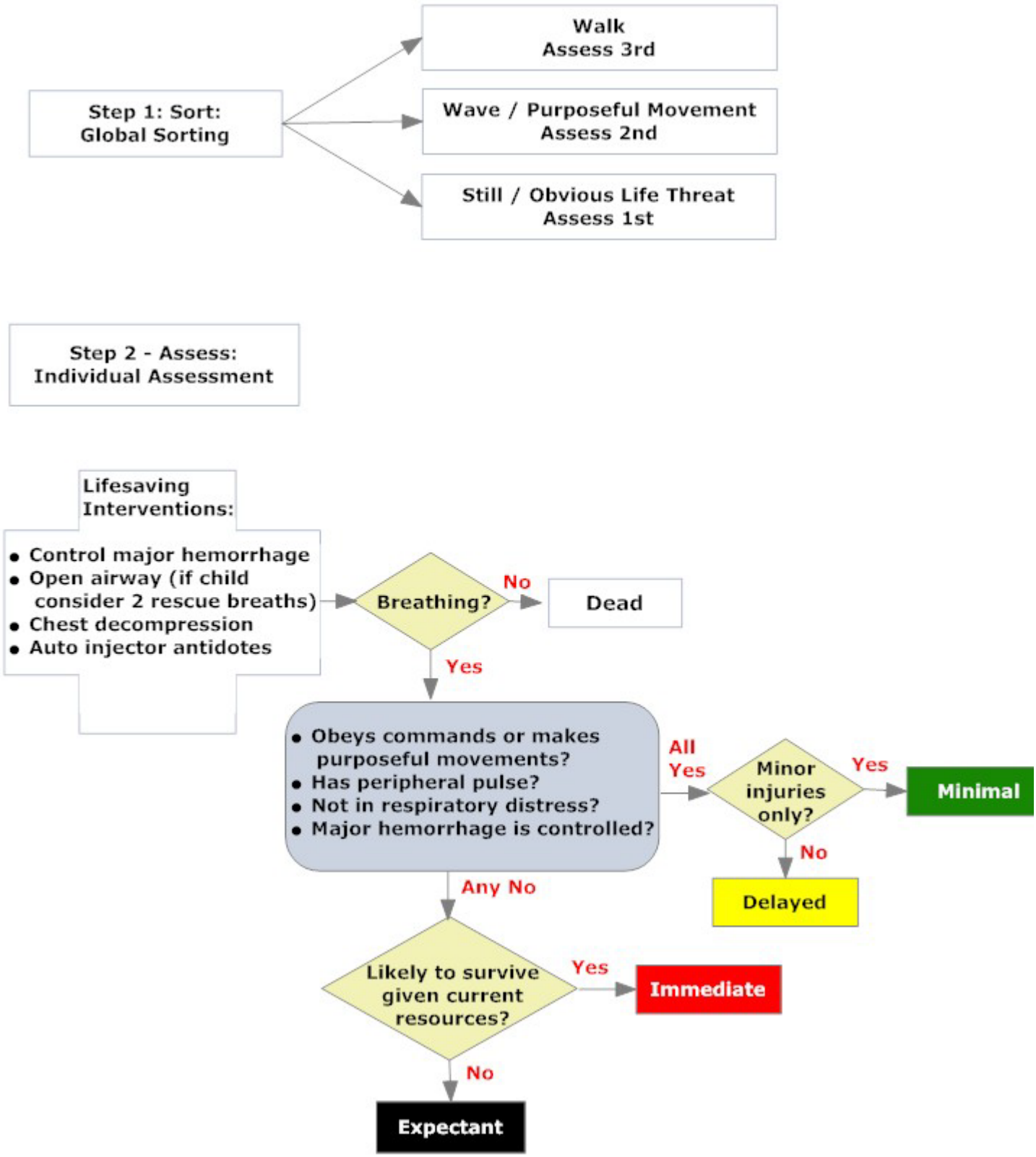
PATIENT SAFETY


Universal Patient Care Protocol
Utilize Broselow® Pediatric Emergency Tape for all weight-based drug administration. Verify correct drug and dose prior to administration.
Prior to flight day, verify presence and operational condition of all equipment, medications, and supplies required for operational readiness.
Following each flight – recheck and verify all supplies stocked and ready. If unable due to operation tempo – attempt to call ahead and have supplies delivered on arrival.
If class VIII items or patient movement items are depleted, advise commander and adjust as necessary to accommodate mission requirements.
All medication errors, clinical errors, or adverse outcomes should be reported to the medical director ASAP.
Assume patient's condition is worse than what is presented. Anticipate deterioration and address aggressively.
Follow appropriate SMOG for patient treatment. Real-time treatment of the patient is the responsibility of the flight medic with the patient.
For any patient that does not fit into a guideline (SMOG), Contact and Consult medical control. If this is not possible, provide standard care within the education, training and scope of the provider, until MTF is reached.

Pearls:

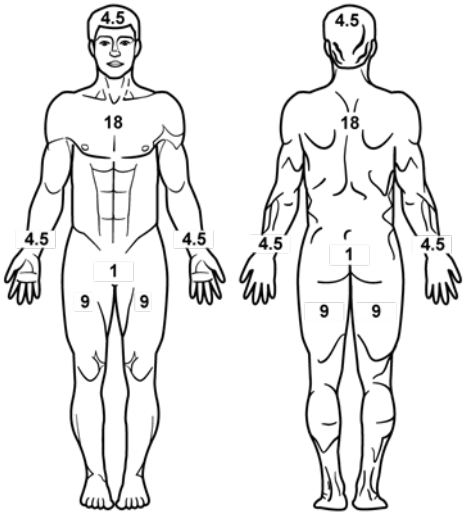
- Supportive care for all patients includes routine monitoring, IV guideline, O_2 / airway support, and fluid resuscitation (as required) to maintain or approach "normal" vital signs.
- Always check and double-check medications, dosage, condition, indication, potential adverse reactions, and control measures prior to administration. Record any patient allergies prior to administration of drugs.
- Check medical supplies and equipment prior to accepting / flying mission. Arrival on scene without proper equipment will result in inability to provide optimal care, and may result in adverse outcomes.
- Any medication / clinical errors or other care-associated concerns should be brought to the attention of the medical officer / director ASAP following the mission or at earliest possible time.

SALT Mass Casualty Triage Algorithm (Sort, Assess, Lifesaving Interventions, Treatment/Transport)



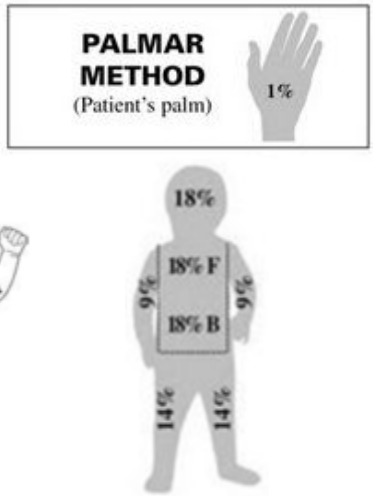
BURN Fluid Resuscitation

Rules of 9 - Burn % Estimation Chart



ADULTS

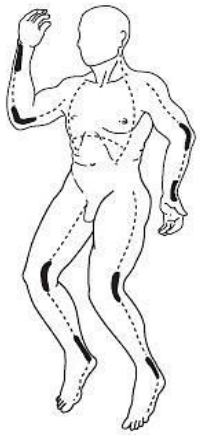
INFANTS



CHILD

Escharotomy-
Dashed line- preferred incision lines.

Bold lines- indicate importance of extending the incision over involved major joints.



Rule of Tens – Fluid Resuscitation Calculations

TBSA > 20%, may require acute fluid resuscitation in prehospital
LR(best)>NS(2nd best)>Hextend(only to 1L)

Adults (>40kg) - **10mL/hr x %TBSA** (estimate to nearest 10%); patients weighing more than 80kg, add 100 ml/hr to IV fluid rate for each 10 kg > 80 kg. Re-evaluate every 1-2 hours. Adjust IV rate to UOP goal 30-50mL (0.5-1 mL/kg in Peds). Adjust IV rate up or down by 20-25%.

Pediatrics (<40kg) - **3 x %TBSA x body weight (kg)** gives the volume for initial 24 hrs. One half is given in first 8 hours. Monitor urine outputwith goal of 0.5 to 1 mL/kg/hr in children.

Example: Pediatric 30kg patient with 50% TBSA 2nd/3rd degree (Chemical or Thermal burn)3mL LR x 50(%TBSA) x 30(kg) = 4,500mL LR in 1st 24hrs
2,250mL (½ of 4,500) is given over 1st 8hrs
2,250mL/8hrs = 281mL/hr for 1st hr, then titrate by 20-25% to UOP goal

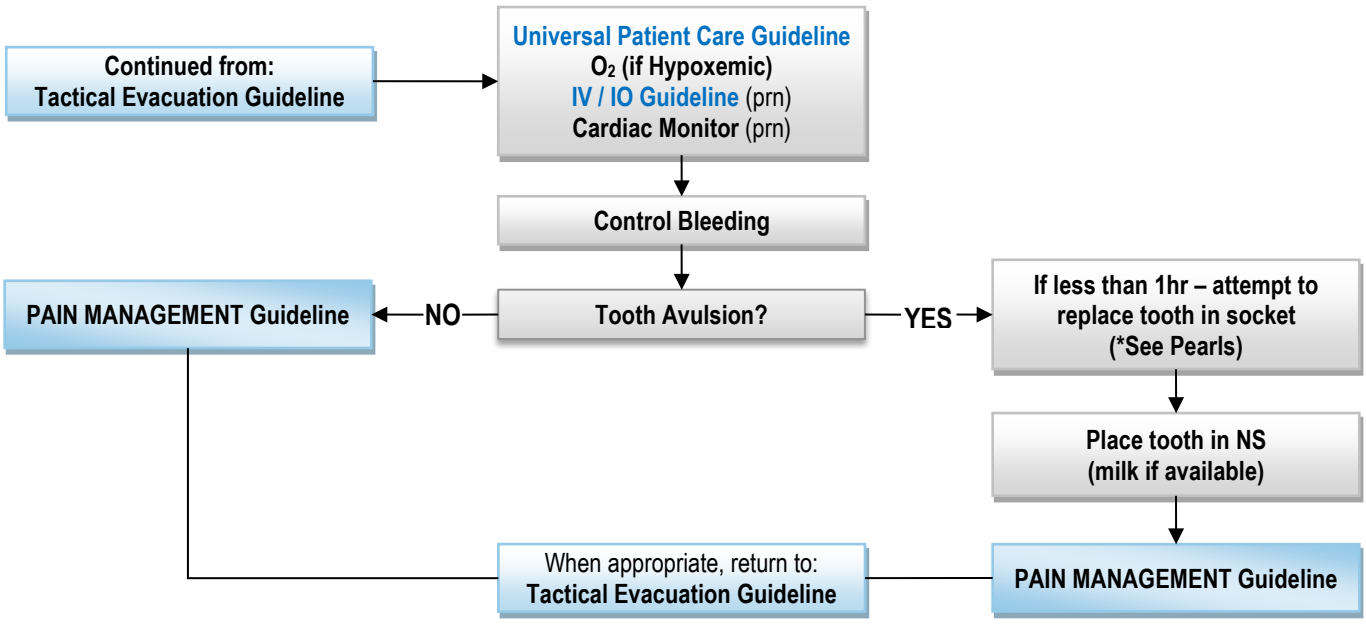
High Voltage Injury: ADULT (>40kg) - 10mL/hr x %TBSA (estimate to nearest 10%); patients weighing more than 80kg, add 100 ml/hr to IV fluid rate for each 10 kg > 80 kg. Re-evaluate every 1-2 hours. Adjust IV rate to UOP goal 75-100mL (1-2 mL/kg in Peds). Adjust IV rate up or down by 20-25%.

Pearls: Both under-resuscitation and over-resuscitation with fluids can precipitate significant adverse clinical eventsfor the burn patient. Thus, it is both worthwhile and imperative that medical aircrew calculate and administer burn resuscitation fluids as accurately and fastidiously as possible. Put another way, it is worth your time and effort to accurately estimate burn surface area, ideal body weight, then calculate and administer appropriate fluids while the patient is under your care.

- Burns with airway involvement require immediate airway protection with Endotracheal Intubation / surgicalairway.
- Burns covering >40% TBSA, will likely require RSI due to airway edema from inflammation/fluid resuscitation.
- **Infants and Young Children should also receive LR with 5% Dextrose at a maintenance rate and monitor for hypoglycemia.**
- Burn patients are prone to hypothermia – must protect from environment. Also, never use ice to cool large burn areas.
- All burns require 100% O2 via NRB unless intubated.
- Never use nitrites for suspected cyanide toxicity in enclosed space fires – can worsen hypoxia. Creates methemoglobinemia. If cyanide toxicity is a tangible threat, consider IV Hydroxycobalmin (CYANOKIT®)

DENTAL PROBLEMS

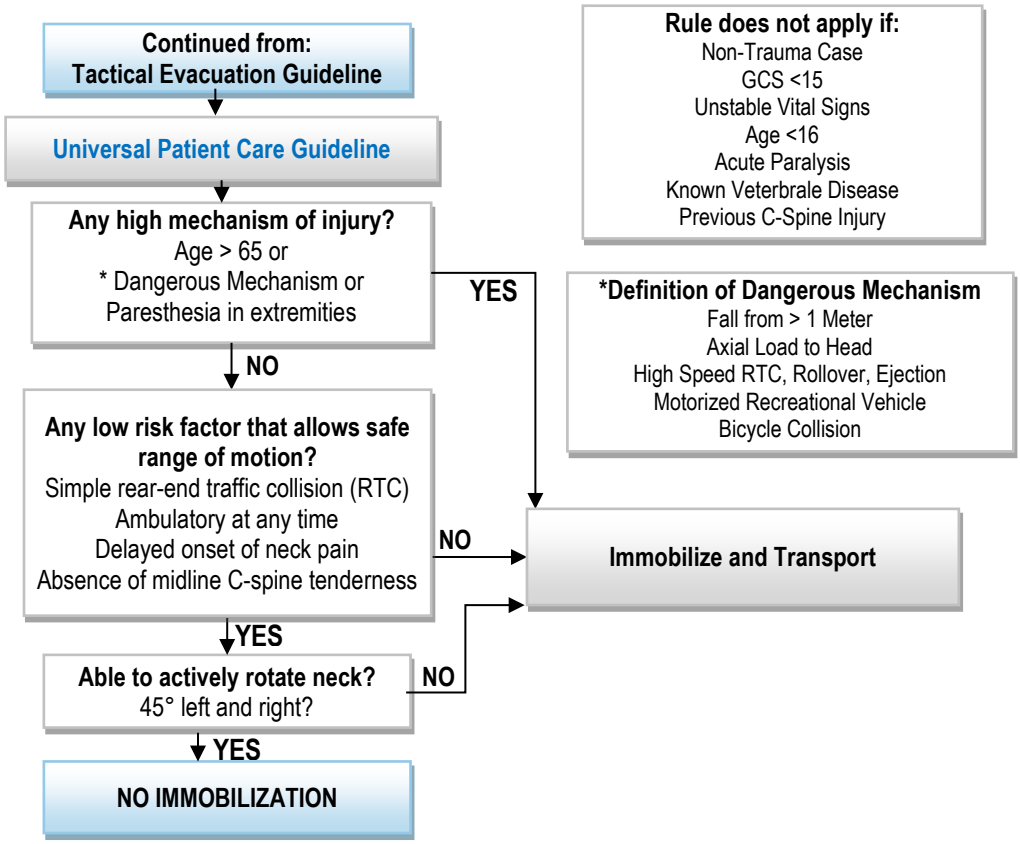
Signs and Symptoms:	Differential Diagnosis:
• **Bleeding**	• **Dental Caries**
• **Pain**	• **Infection**
• **Fever**	• **Fracture**
• **Swelling**	• **Avulsion**
• **Missing / Fractured Tooth**	• **Abscess / Cellulitis**
	• **Gingivitis**



Pearls:

- Significant soft tissue swelling to face / mouth can represent cellulitis or an abscess.
- **Avulsion** (Complete Avulsion Only)
  - Gently rinse (do not scrub) tooth with NS and attempt to re-implant with firm pressure into the socket. **Never perform this in children with primary teeth**.
  - As able and without obstructing airway, place bulky dressing over tooth and use as a soft bite block to stabilize tooth. Instruct to bite down gently, do not move jaw.
- **Subluxation** (tooth displaced in socket)
  - Treatment not always required.
  - For obviously loose or displaced tooth consider placing bulky dressing over tooth and use as a soft bite block to stabilize tooth. Instruct to bite down gently, do not move jaw.
- Occasionally, cardiac chest pain can radiate to the jaw.
- Patient with dental abscess may experience significant pain at altitude due to gas volume expansion at lower atmospheric pressure. Consider flying at lower altitude and refer to pain management guideline.

SPINAL EVALUATION & IMMOBILIZATION/CANADIAN C-SPINE RULE (CCR)



CONTRAINDICATIONS:

- Patients with isolated penetrating cervical injury who are conscious and have no neurologic signs should not have a cervical collar placed in the pre-hospital environment.

PROCEDURE:

- Evaluation should take place after the primary survey and all emergent procedures completed. However, during the primary survey, the spine should be protected by manual inline stabilization / limited movement prior to completion of spinal examination. This does not apply to situations in which imminent danger exists and immediate movement is necessary.

Document procedure, results, and vital signs.

- On the battlefield, safety of patient and medical personnel are paramount. In hostile situations, evacuation to a more secure area takes precedence over spine immobilization.

FOLEY CATHETER PLACEMENT

CLINICAL INDICATIONS:

- Bladder distention in an unconscious person, or for blockage / inability to urinate in conscious person.
- Allows for accurate monitoring of output for fluid management.

CONTRAINDICATIONS:

- Known or suspected urethral disruption resulting from pelvic trauma.
- Combative or uncooperative patient.

PROCEDURE:

- Choose appropriate catheter (16-18 for adults) and ready equipment.
- Position patient. Females in supine position with legs abducted. Cleanse urethra and surrounding area with antiseptic solution. Isolate area with drapes provided.
- Insert xylocaine jelly provided into urethra with the syringe provided.
- Insert catheter into urethra. For **females** advance the catheter approx. 3 inches. For **males**, pass catheter into the bladder the full length to the junction of the catheter and inflation port for balloon.
- Once urine is obtained, inflate balloon with 5cc NS, then pull catheter outward until balloon against bladder neck. If no urine return is given and procedures to induce urine return (bladder palpation) do not work, DO NOT inflate the balloon.
- Secure catheter to leg with tape to prevent trauma to urethra. Document procedure.

Document procedure, results, and vital signs.

NASO / OROGASTRIC TUBE

CLINICAL INDICATIONS:

- Enabling gastric decompression, decreasing risk of vomiting and aspiration, obtain sample of gastric contents.
- Allows for gastric lavage in drug overdose or poisoning.

CONTRAINDICATIONS:

- Nasogastric tubes contraindicated in the presence of massive facial trauma, burns, or suspicion of basilar skull fracture (CSF otorrhea, Battle's sign, raccoon eyes, mechanism). May insert orogastric tube instead.

PROCEDURE:

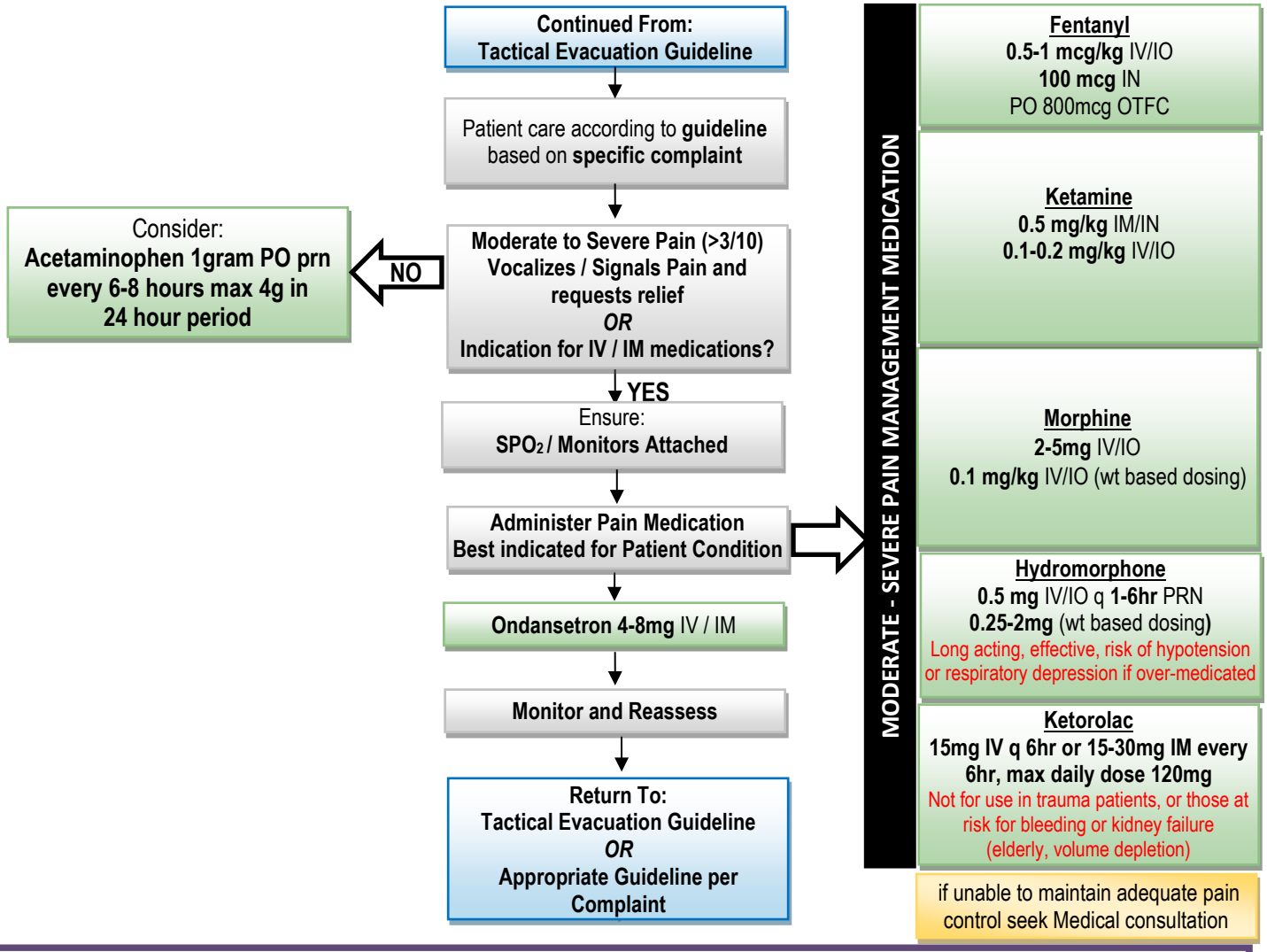
- If possible, sit patient upright for optimal neck and stomach alignment.
- Measure tubing from bridge of nose to earlobe, then to the point halfway between the end of the sternum and the navel. Mark measured tube with marker.
- Select most patent nare (or the throat) and pass lubricated tube in a posterior – NOT SUPERIOR – direction. If resistance is met, attempt to corkscrew slightly or remove and attempt in other nare.
- Withdraw tube immediately if changes occur in patient's respiratory status, if tube coils in mouth, if the patient begins to cough, or becomes cyanotic.
- Advance tube until mark is reached.
- Verify tube placement by listening over stomach while air is passed or examining aspirate when applied to suction. Secure tube. Watch vital sign for changes.

Document procedure, results, and vital signs.

PAIN MANAGEMENT

Signs and Symptoms:

- **Tachycardia**
- **Diaphoresis**
- **Elevated Blood Pressure**
- **Vocalizes and/or Signals Pain**


Continued From:
Tactical Evacuation Guideline
Patient care according to guideline based on specific complaint
Moderate to Severe Pain (>3/10)
Vocalizes / Signals Pain and requests relief
OR
Indication for IV / IM medications?
NO
Consider:
Acetaminophen 1gram PO prn every 6-8 hours max 4g in 24 hour period
YES
Ensure:
SPO2 / Monitors Attached
Administer Pain Medication
Best indicated for Patient Condition
Ondansetron 4-8mg IV / IM
Monitor and Reassess
Return To:
Tactical Evacuation Guideline
OR
Appropriate Guideline per Complaint
MODERATE - SEVERE PAIN MANAGEMENT MEDICATION
Fentanyl
0.5-1 mcg/kg IV/IO
100 mcg IN
PO 800mcg OTFC
Ketamine
0.5 mg/kg IM/IN
0.1-0.2 mg/kg IV/IO
Morphine
2-5mg IV/IO
0.1 mg/kg IV/IO (wt based dosing)
Hydromorphone
0.5 mg IV/IO q 1-6hr PRN
0.25-2mg (wt based dosing)
Long acting, effective, risk of hypotension or respiratory depression if over-medicated
Ketorolac
15mg IV q 6hr or 15-30mg IM every 6hr, max daily dose 120mg
Not for use in trauma patients, or those at risk for bleeding or kidney failure (elderly, volume depletion)
if unable to maintain adequate pain control seek Medical consultation

Pearls:

- Document patient's medications and all allergies prior to administration of medications.
- PO medications should not be used in any patient with altered mental status or anyone in whom surgery is anticipated, unless directed by transferring provider.
- **Narcotic pain medications can be reversed with Naloxone 0.4-2mg IV.**
- Start with low dosage of pain medications and titrate upward to desired effect.
- Fentanyl and Morphine will cause a decrease in BP through various drug effects. Fentanyl is preferred over Morphine for immediate pain control.
- **Treatment of "Ketamine Associated Psychiatric Distress" or "Ketamine induced agitation,"**
  - **Midazolam 2-5mg IV x1 prn for agitation due to Ketamine administration**
- Morphine and/or Ketamine auto-injectors may be used if available; however IV / IO route is preferred.
- Ketamine can cause slight decrease in blood pressure, especially with hypotensive shock patients, lower doses are recommended in this type of patient.
- Fentanyl OTFC 800mcg may be used if patient is conscious. Do NOT CHEW

Pediatric PAIN MANAGEMENT
Vital Functions and Pain Scale

Signs and Symptoms:
- **Tachycardia, Diaphoresis, Elevated Blood Pressure, Cry, Grimace, Splinting, Guarding**

AVERAGE PEDIATRIC VITAL FUNCTIONS

BROSELOW cm	<61cm	61cm	67cm	75cm	87cm	96cm	109cm	122cm	138cm	149+cm
(approx) weight	3-5kg	6-7kg	8-9kg	10-11kg	12-14kg	15-18kg	19-23kg	24-29kg	30-36kg	37>kg
AGE	MONTHS					YEARS				
	0 1 2 3 4 5 6 7 8 9 10 11			1	2	3 4	5 6	7 8	9 10	11 12-16
HEART RATE	107-181	93-161		88-156	70-142	59-131		52-115		43-108
RESP RATE	25-66	22-64		19-53	17-38	16-29		14-25		12-23
SYSTOLIC BP	60	79-105		85-108		88-110	91-119		97-137	
DIASTOLIC BP		34-81		40-69		45-68	51-89		59-86	
URINE (mL/kg/hr)	2			1.5		1			0.5	

Weights and lengths in above chart are estimates, to achieve most accuracy utilize Broselow tape on patient

Pediatric FLACC Pain Scale

(2 Months – 7 Years or Individuals Unable to Communicate)

Score of 5-10 = Moderate-Severe Pain, Consider Narcotic

Criteria	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, uninterested	Frequent to constant quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting, back and forth, tense	Arched, rigid or jerking
Cry	No cry (awake or asleep)	Moans or whimpers; occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging or being talked to, distractible	Difficult to console or comfort

In hemodynamically unstable or inconsolable child, consider:

Ketamine

(IV / IO Push over 1 min)
- Analgesia:
  IM / IN: 0.4 mg/kg
  IV / IO: 0.3 mg/kg
- Induction / Dissociative:
  IV / IO: 1-2 mg/kg

FENTANYL 0.5-2mcg/kg SIVP
q 20-30min (Max 4mcg/kg)

MORPHINE 0.1mg/kg IV SIVP/IM
q 120min (Max 0.4mg/kg)

Follow Procedural steps of:
PAIN MANAGEMENT GUIDELINE
Utilize Appropriate Medication in Pediatric Dose.

Acetaminophen 10-15mg/kg PO / PR

ONDANSETRON (for Nausea)
- **≤40kg 0.1mg/kg IV**
- **>40kg 4mg IV**

HYPOTHERMIA PREVENTION AND MANAGEMENT

CLINICAL BACKGROUND:

- Hypothermia, acidosis, and coagulopathy constitute the "triad of death" in trauma patients. The association of hypothermic coagulopathy with increased mortality has been well described. Over 80% of non-surviving patients have had a body temperature of less than 93.2°F(34°C). This degree of hypothermia causes dysfunction of coagulation proteins, thus exacerbating hemorrhage. The mortality in combat casualties with hypothermia is double that of normothermic casualties with similar injuries.
- Prevention of hypothermia must be emphasized in combat operations and casualty management at all levels of care. Take early and aggressive steps to prevent further body heat loss and add external heat when possible for both trauma and severely burned casualties.
- Hypothermia occurs regardless of the ambient temperature; hypothermia can, and does, occur in both hot and cold climates.
- Prevention of hypothermia is much easier than treatment of hypothermia; therefore prevention of heat loss should start as soon as possible after the injury. This is optimally accomplished in a layered fashion with rugged, lightweight, durable products that are utilized at all subsequent levels of care, including ground and air evacuation, through all levels of care.

CONTRAINDICATIONS:

- Hyperthermia patients that require active cooling

PROCEDURE: Tactical Combat Casualty Care principles should be followed for preventing hypothermia.

- Primary Equipment
    - Hypothermia Prevention and Management Kits (HPMK). HPMK contains:
        - strong, flexible, lightweight Heat Reflective Shell that is impervious to wind & rain
        - Hood cover for Head
        - self-heating, oxygen-activated shell liner (ReadyHeat)
    - Blood Fluid Warmers
    - ReadyHeat Blankets
    - Wool or heat shield blankets

Take aggressive action to prevent hypothermia and maintain normothermic temperatures 97°-99° F (36°- 38° C)

- **Blood/Fluid Warmers:** Utilize blood/fluid warmers for all IV/IO administration. Fluids should be warmed to 38° Celsius.

- **Head Cover:** Cover patients head with hood or Thermo-Lite Hypothermia Prevention System Cap. Greatest area of heat loss happens at the top of the patients head.

- **ReadyHeat Blankets:** Place the ReadyHeat Blanket on the torso and back of the casualty with a layer of clothing or a sheet or wool blanket between the casualty's skin and the Ready-Heat Blanket.
- **Cover Patient:** Utilize Heat Reflective Shell, rescue or wool blankets to cover the patient. Use blankets to insulate patient from cold surfaces.
- **Remove Wet Clothing:** Remove wet clothing and attempt to dry patient.
- **Close doors and windows:** Reduce heat loss from convection over the patient and cooling of the environment.
- **Cabin Auxiliary Heater:** Even on mildly warm days, use cabin aux heat to maintain treatment area temperature of >85° – 90° Fit
- **Limit Exposure**: only expose areas necessary to visualize and work on the patient. Cover exposed areas as soon as able following procedures.

Continuously monitor patient and record temperature. A core temperature should be taken for best accuracy.

Document procedure, results, and vital signs.

Vital Functions
Assessment Reference Charts

AVERAGE VITAL FUNCTIONS by age

BROSELOW cm (approx) weight	<61cm 3-5kg	61cm 6-7kg	67cm 8-9kg	75cm 10-11kg	87cm 12-14kg	96cm 15-18kg	109cm 19-23kg	122cm 24-29kg	138cm 30-36kg	149+cm 37>kg
AGE	MONTHS			YEARS						
	0 1 2 3 4 5 6 7 8 9 10 11			1	2	3 4	5 6	7 8 9	10 11	12-16
HEART RATE	107-181	93-161		88-156	70-142	59-131		52-115		43-108
RESP RATE	25-66	22-64		19-53	17-38	16-29		14-25		12-23
SYSTOLIC BP	60	79-105		85-108		88-110	91-119		97-137	
DIASTOLIC BP		34-81		40-69		45-68	51-89		59-86	
URINE (mL/kg/hr)	2			1.5		1			0.5	

Weights and lengths in above chart are estimates, to achieve most accuracy utilize Broselow tape on patient

Oxygen Saturation

	Sea Level	5,000 Feet MLS
SpO_2 (Peripheral O_2 Sat)	>94% for patient with Normal Hemoglobin level	>92%
StO_2 (Tissue O_2 Sat)	>75-95%	Same (<75% = Poor Perfusion)
$EtCO_2$	35-45 mmHg	

Vital Functions
Assessment Reference Charts

GLASGOW COMA SCALE

SCORE	ADULT	CHILD	INFANT
Eye Opening			
4	Spontaneous	Eye Opening Response Same as Adult	
3	To Speech		
2	To pain		
1	None		
Verbal Response			
5	Oriented	Oriented	Coos and babbles
4	Confused Conversation	Confused Conversation	Irritable, Cries
3	Inappropriate Words	Inappropriate Words	Cries in Response to pain
2	Incomprehensible Sounds	Incomprehensible Words/Sounds	Moans in Response to Pain
1	None	None	None
Best Motor Response			
6	Obeys Commands	Obeys Commands	Moves Spontaneously
5	Localizes Pain	Localizes Pain	Withdraws to Touch
4	Flexion Withdrawal to Pain	Flexion Withdrawal to Pain	Withdraws from Pain Stimulus
3	Abnormal Flexion (Decorticate)	Abnormal Flexion (Decorticate)	Abnormal Flexion (Decorticate)
2	Extension (Decerebrate)	Extension (Decerebrate)	Extension (Decerebrate)
1	None (Flaccid)	None (Flaccid)	None (Flaccid)

For Intubated Patient use **Verbal "T"**
(Example: Eyes open to pain, Intubated, and Localizes would be E2,V1,M5, or **GCS 8T**)

Vital Functions
Assessment Reference Charts

MUSCULOSKELETAL INJURY and PERIPHERAL NERVE ASSESSMENT

UPPER EXTREMITIES

INJURY to Consider	MOTOR Testing	SENSATION Testing	NERVE
Elbow Injury	Index and Little Finger Abduction	Little Finger	Ulnar
Wrist Fracture or Dislocation	Thenar Contraction with Opposition	Index Finger	Median Distal
Supracondylar Fracture of Humerus	Index Tip Extension	None	Median, Anterior Interoseous
Anterior Shoulder Dislocation	Elbow Flexion	Radial Forearm	Musculocutaneous
Distal Humeral Shaft, Anterior Shoulder Dislocation	Thumb, Finger group Extension	First Dorsal Web Space	Radial
Anterior Shoulder Dislocation, Proximal Humerus Fracture	Deltoid	Lateral Shoulder	Axillary

LOWER EXTREMITIES

Pubic Rami Fractures	Knee Extension	Anterior Knee	Femoral
Obturator Ring Fractures	Hip Adduction	Medial Thigh	Obturator
Posterior Tibial	Toe Flexion	Sole of Foot	Knee Dislocation
Fibular Neck Fracture, Knee Dislocation	Ankle Eversion	Lateral Dorsum of Foot	Superficial Peroneal
Fibular Neck Fracture, Compartment Syndrome	Ankle / Toe Dorsiflexion	Dorsal 1st-2nd Web Space	Deep Peroneal
Posterior Hip Dislocation	Plantar Flexion	Foot	Sciatic Nerve
Acetabular Fracture	Hip Abduction	Upper Buttocks	Superior Gluteal
Acetabular Fracture	Hip Extension	Lower Buttocks	Inferior Gluteal

MUSCLE STRENGTH GRADING

SCORE	EXAM RESULT
0	Total Paralysis
1	Palpable or Visible Contraction
2	Full Range of Motion Without Gravity
3	Full Range of Motion Against Gravity
4	Full Range of Motion, but Less than Normal Strength
5	Normal Strength
NT	Not Testable

Vital Functions
Assessment Reference Charts

PEDIATRIC ALS EQUIPMENT
(Always use a Broselow® Pediatric Emergency Tape if available)

BROSELOW cm	<61cm	61cm	67cm	75cm	87cm	96cm	109cm	122cm	138cm	149+cm
(approx) weight	3-5kg	6-7kg	8-9kg	10-11kg	12-14kg	15-18kg	19-23kg	24-29kg	30-36kg	37>kg
AGE	MONTHS					YEARS				
	0 1 2 3 4 5 6 7 8 9 10 11			1	2	3 4	5 6	7 8 9	10 11	12-16
RESUSCITATION BAG	Infant	Child					Child/Adult			Adult
O2 MASK	Newborn			Pediatric				Adult		
ORAL AIRWAY	Infant/Small Child			S Child	Child			Child/S Adult		Med Adult
BAG MASK	Infant	Pediatric						Peds/Adult		
LARYNGOSCOPE	0-1	1 Straight			2 Strait	2Straight/Curved		2-3 St/Curv		3 St/Curved
ET TUBE	2.5-3 Uncufd	3.5 Uncuffed		4 Un cuffed	4.5 Un cuffed	5 Un cuffed	5.5 Un cuffed	6 Cuffed	6.5 Cuffed	
STYLET	6						14			
SUCTION	6-8	8		8-10	10				12	
BP CUFF	Newborn/Infant			Infant/ Child	Child			Child/ Adult	Adult	
IV CATHETER	22-24			20-24	18-22		18-20		16-20	
OG/NG TUBE	5-8			8-10	10	10-12	12-14	14-18	18	
CHEST TUBE	10-12			16-20	20-24		24-32	28-32	32-40	
URINARY CATHETER	5-8			8-10	10	10-12		12		
CERVICAL COLLAR	N/A	Small					S/M	Medium		M/L

Weights and lengths in above chart are estimates, to achieve most accuracy utilize Broselow tape on patient

BROSELOW cm	<61cm	61cm	67cm	75cm	87cm	96cm	109cm	122cm	138cm	149+cm	
(approx) weight	3-5kg	6-7kg	8-9kg	10-11kg	12-14kg	15-18kg	19-23kg	24-29kg	30-36kg	40kg	45
pounds	6-11	13-15	17-20lbs	22-25	27-32	34-41	42-52	54-65	67-80	90	101
AGE	MONTHS			YEARS							
	0 1 2 3 4 5 6 7 8 9 10 11			1	2	3 4	5 6	7 8 9	10 11	12-16	
FLUID BOLUS	80ml	130	170ml	210ml	260ml	340ml	420ml	500ml			
ZOLL DEFIB ENERGY 1st	8J	10J	15J	20J		30J		50J		75J	
2nd	15J	20J	30J		50J		75J	100J	120J	150J	
MAXIMUM	30J	50J	75J	100J	120J	150J		200J			

Weights and lengths in above chart are estimates, to achieve most accuracy utilize Broselow tape on patient

ZOLL® Defibrillation Energy Settings for PEDIATRIC Patients

COMMON LABORATORY VALUES

Laboratory	Chemistry Conventional		SI Units	
Anion Gap	8-16 mEq/L		8-16 mmol/L	
BUN	8-25 mg/100mL		2.9-8/9 mmol/L	
Calcium	8.5-10.5 mg/100mL		2.1-2.6 mmol/L	
Carbon Dioxide	24-30 mEq/L		24-30 mmol/L	
Creatine	**Male**	0.2-0.5 mg/dL	**Female**	0.3-0.9mg/dL
Creatine Kinase	**Male**	17-40 U/L	**Female**	10-79 U/L
Creatinine	0.6-1.5 mg/100L		53-133	
Glucose	70-110 mg/100mL		3.9-5.6 mmol/L	
Sodium	135-145 mEq/L			
Potassium	3.5-5.0 mEq/L		3.5-5.0 mmol/L	
Hematology				
Hemoglobin	**Male**	13-18 g/100 mL	**Female**	12-16 g/100mL
Hematocrit	**Male**	41-50%	**Female**	36-44%
Platelets	140,000-450,000/ml			
Cardiac Markers				
Troponin I*	**Onset**	4-6 hrs.	**Peak**	12-24 hrs.
Troponin T*	**Onset**	3-4 hrs.	**Peak**	10-24 hrs.
Myoglobin	**Male**	10-95 ng/ml	**Female**	10-65 ng/ml
	Onset	1-3 hrs.	**Peak**	Peak: 6-10 hrs.
INR only if Tx for DVT	0.8-1.2		2.0-3.0	
Normal Blood Gasses				
pH	7.35-7.45			
Pco2	35-45 mm Hg			
HCO3	22-26 mmol/L			
Base excess	(-2)-(+2) mEq/L			
CO2	19-24 mEq/L			
SaO2	96-100%			

***Troponin assays are becoming more analytically sensitive. Each device has different reference ranges associated. Correlate cTn with reference lab. Point of care readers are less sensitive.**

USEFUL CALCULATIONS

PEDIATRIC FORMULAS:

- **ETT Size = (**Age/4)+4 (Age divided by 4 plus 4)
- **ETT Depth =** 3 x ETT Size (Endotracheal)
- **Weight in kg** (>1 year) = (Age (years) x 2) + 8
- **Systolic Blood Pressure minimum** = 70 + [2 x Age (years)]

MEDICATION FORMULAS:

- **Mcg/kg/min (micrograms/kilogram/minute)** = [16.7 X Drug Concentration (mg/ml) x infusion rate (ml/h)] Weight (kg).
- **INFUSION RATE (ml/h)** = [Desired mcg/kg/min x Weight (kg) x 60]/Drug concentration (mcg/mL)

HEMODYNAMIC FORMULAS:

- **MAP**: Mean Arterial Pressure = [(2 x DBP) + SBP]/3.
- **SBP** = (Systolic Blood Pressure)
- **DBP** = (Diastolic Blood pressure)
- / = (Divided by)
- **PULSE PRESSURE:** SBP – DBP or (Systolic Blood Pressure minus Diastolic Blood pressure).
- **Cerebral Profusion Pressure (CPP):** MAP-ICP=CPP
- **ICP**= (Intracranial Pressure)
- **Ideal CPP=>65** While ICP cannot often be measured during flights; an assumption that patients with TBI have an ICP of 15-20 will allow hemodynamic optimization in these patients to ensure adequate CPP.

Common Conversions:

- lbs. = kg x 2.2 or kg = lbs. x 0.45
- Fahrenheit = (Celsius x 1.8) + 32 or Celsius = (Fahrenheit -32) x 5/9
- 1 tsp. = 5 ml
- 1 tbsp. = 15 ml
- 1 oz. = 30 ml
- 1g = 1,000 mg
- 1mg = 1,000 mcg
- 1 g = 10,000 mcg

OXYGEN CYLINDER LIFE:

Cylinder	D	E	G	H
Liters	**356**	622	5260	6900
Flow (LPM)	**Length of use (min)**	**Length of use (min)**	**Length of use (min)**	**Length of use (min)**
2	**178**	311	2630	3450
4	**89**	155	1315	1725
6	**59**	104	876	1150
8	**44**	78	658	862
10	**35**	62	526	690
12	**30**	52	438	575
15	**23**	41	350	460

NOTE: Current MEDEVAC Oxygen Cylinder is "D" type.

To estimate duration of use for Oxygen Cylinders:

- Duration of Flow = Contents of cylinder / Flow rate.

Cylinder Factors for Calculation of Duration of Oxygen Flow:

- **Cylinder Size** D E G H and K
  Factor 0.16 0.28 2.41 3.14

Once you have the cylinder factor and the amount of pressure remaining in the cylinder, the duration of flow can be calculated with the following equation.

Duration of flow (min) = Pressure (psig) x Cylinder Factor/Flow (L/min)

Lund-Browder Burn Estimate Chart – Adult

Total Area front/back (circumferential)		one side--anterior	one side--posterior	Do not include in total TBSA			
	Adult	adult	adult	1st °	2nd °	3rd °	TBSA
Head	7	3.5	3.5				0
Neck	2	1	1				0
Anterior trunk*	13	13	0				0
Posterior trunk*	13	0	13				0
Right buttock	2.5	na	2.5				0
Left buttock	2.5	na	2.5				0
Genitalia	1	1	na				0
Right upper arm	4	2	2				0
Left upper arm	4	2	2				0
Right lower arm	3	1.5	1.5				0
Left lower arm	3	1.5	1.5				0
Right hand	2.5	1.25	1.25				0
Left hand	2.5	1.25	1.25				0
Right thigh	9.5	4.75	4.75				0
Left thigh	9.5	4.75	4.75				0
Right leg	7	3.5	3.5				0
Left leg	7	3.5	3.5				0
Right foot	3.5	1.75	1.75				0
Left foot	3.5	1.75	1.75				0
	100	48	52	0	0	0	0

Age:	
Sex:	
Weight:	

Patient Identification

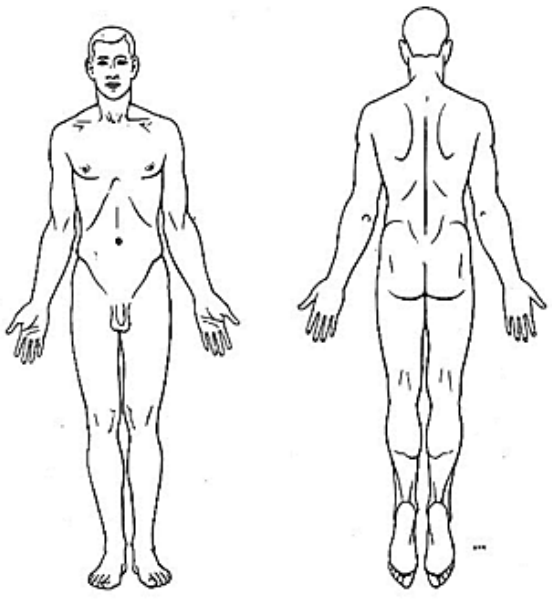


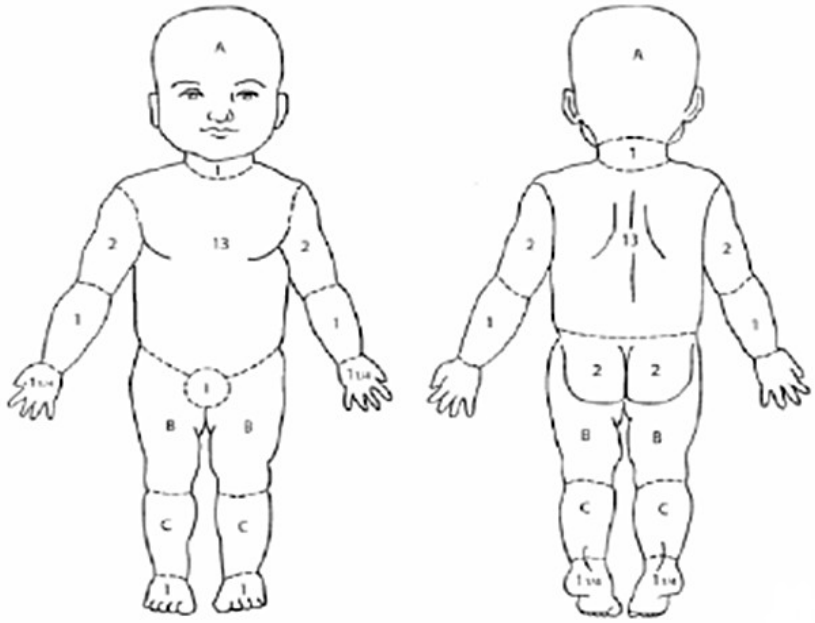
DIAGRAM A

Lund-Browder Burn Estimate Chart – Infant

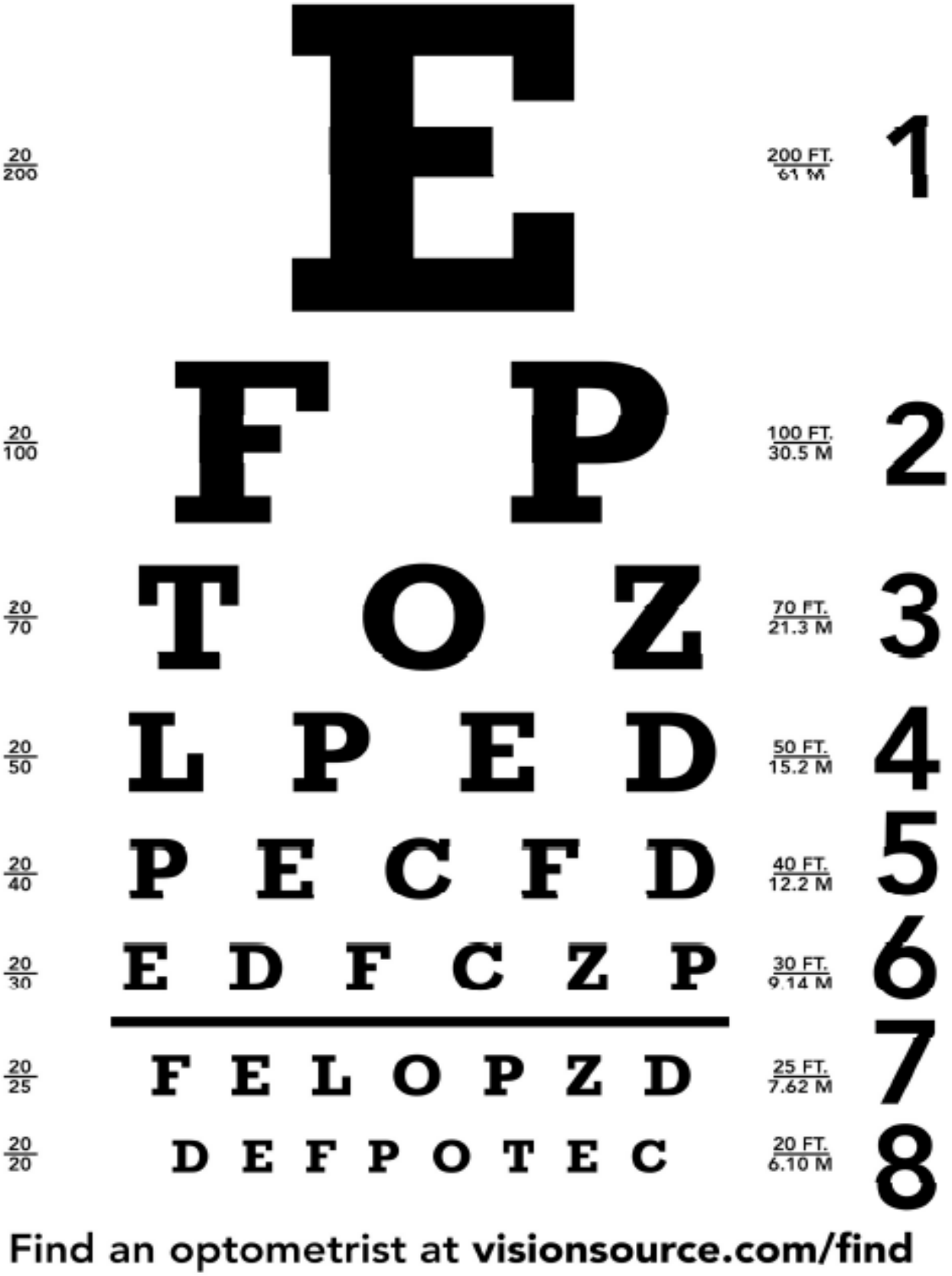
Pediatric Lund Browder Burn Estimate & Diagram

Total Area front/back (circumferential)	1 to 4 years	5 to 9 years	10 to 14 years	15 years	Do not include in total TBSA 1st	2nd °	3rd °	TBSA
Head	17	13	11	9				0
Neck	2	2	2	2				0
Anterior trunk*	13	13	13	13				0
Posterior trunk*	13	13	13	13				0
Right buttock	2.5	2.5	2.5	2.5				0
Left buttock	2.5	2.5	2.5	2.5				0
Genitalia	1	1	1	1				0
Right upper arm	4	4	4	4				0
Left upper arm	4	4	4	4				0
Right lower arm	3	3	3	3				0
Left lower arm	3	3	3	3				0
Right hand	2.5	2.5	2.5	2.5				0
Left hand	2.5	2.5	2.5	2.5				0
Right thigh	6.5	8	8.5	9				0
Left thigh	6.5	8	8.5	9				0
Right leg	5	5.5	6	6.5				0
Left leg	5	5.5	6	6.5				0
Right foot	3.5	3.5	3.5	3.5				0
Left foot	3.5	3.5	3.5	3.5				0

1	
2	
3	



SNELLEN CHART


20/200 E 200 FT. 61 M 1
20/100 F P 100 FT. 30.5 M 2
20/70 T O Z 70 FT. 21.3 M 3
20/50 L P E D 50 FT. 15.2 M 4
20/40 P E C F D 40 FT. 12.2 M 5
20/30 E D F C Z P 30 FT. 9.14 M 6
20/25 F E L O P Z D 25 FT. 7.62 M 7
20/20 D E F P O T E C 20 FT. 6.10 M 8
Find an optometrist at visionsource.com/find

EXAMPLE Standing Order Sheet for Critical Care Patient Transfers

PATIENT IDENTIFICATION

(Last, First, Middle Initial; SSN/Identification Number; grade; DOB; treatment facility)

Date:

Sending Facility:

Sending Physician:

Receiving Facility:

Diagnosis:

Condition:

Patient Category:

Allergies:

Height:

Weight (kg):

Fluids: [ ] LR mL/hr [ ] NS mL/hr [ ] 3% Saline mL/hr [ ] D5W [ ] Other_____ [ ] PRBC [ ] FWB [ ] Plasma [ ] LTOWB

Monitoring: [ ] Vital Signs [ ] Every 5 min Vital Signs [ ] Every 15 min Vital Signs [ ] Every 30 min [ ] Continuous cardiac monitoring, document rhythm strips pre-flight and with any rhythm changes [ ] ICP/CPP [ ] CVP [ ] GCS [ ] ETCO2 [ ] UO_____mL hourly

Activity: [ ] Bed rest

[ ] Spine precautions: C-Collar/C-Spine TLS Spine

Nursing: [ ] Wound VAC dressing to _____mm Hg suction

[ ] NGT to low continuous suction OR [ ] Clamp NGT

[ ] OGT to low continuous suction OR [ ] Clamp OGT

[ ] Chest tube 1 to: water seal (circle: R L Both) OR _____cm H2O Suction (circle: R L Both) [ ] Chest tube 2 to: water seal (circle: R L Both) OR _____cm H2O Suction (circle: R L Both) [ ] Chest tube 3 to: water seal (circle: R L Both) OR _____cm H2O Suction (circle: R L Both) [ ] Chest tube 4 to: water seal (circle: R L Both) OR _____cm H2O Suction (circle: R L Both) [ ] Keep HOB elevated _____ degrees [ ] Keep HOB flat

Respiratory: [ ] Keep O2Sat >_____ %

Oxygen: [ ] Nasal Cannula at _____LPM [ ] Non-rebreather at _____ LPM

Ventilator Settings: Mode: [ ] SIMV [ ] AC [ ] CPAP [ ] BiPAP

Rate: _____breaths per minute I:E ratio:_____

Tidal Volume: _____ mL FiO2:_____ % PEEP: _____cm H2O PIP: _____

PATIENT IDENTIFICATION

(Last, First, Middle Initial; SSN/Identification Number; grade; DOB; treatment facility)

Vasoactive Medications:

[ ] Dopamine ___mg/___mL at____mcg/kg/min IV; titrate to MAP > _____mm Hg

[ ] Norepinephrine 4mg/___mL at____mcg/min IV; titrate to MAP >_____ mm Hg

[ ] Phenylephrine 10mg/____mL at____mcg/min IV; titrate to MAP >_____ mm Hg

[ ] Epinephrine __mg (1:10,000)/___mL at____mcg/min IV; titrate to MAP >_____ mm Hg [ ] Other_____

Sedation and Analgesics:

[ ] Ketamine __mg/kg Q___minutes IVP PRN sedation to Riker Sedation-Agitation Scale of 1-2 [ ] Midazolam ___mg Q___minutes IVP PRN sedation to Riker Sedation-Agitation Scale of 1-2 [ ] Haloperidol ___mg Q___minutes IVP PRN sedation to Riker Sedation-Agitation Scale of 1-2 [ ] Lorazepam ___mg Q___minutes IVP PRN sedation to Riker Sedation-Agitation Scale of 1-2 [ ] Fentanyl ____mcg Q___minutes IVP PRN pain

[ ] Morphine ___mg Q___minutes IVP PRN pain

[ ] Other_____

Paralytics:

[ ] Rocuronium _____mg IVP

[ ] Vecuronium _____mg IVP

Intracranial Hypertension:

[ ] 3% Hypertonic Saline 250 cc bolus for any signs of herniation

[ ] Mannitol Infusion Rate: _____

Labs:

[ ] ABG 15 minutes prior to departing sending facility

[ ] Other:

Additional critical information:

Physician Signature:

JTS BURN RESUSCITATION WORKSHEET

United States Army Institute of Surgical Research Phone Numbers
Comm: (210) 916-2876 (BURN)
DSN: 312-429-2876

Initiate AFTER *completion of trauma assessment and interventions*
Adults only: *Refer to Burn CPG for pediatric specific recommendations*

1. Contact USAISR Burn Center (DSN 312-429-2876) or email: burntrauma.consult.army@mail.mil

Date/Time contact: _____POC:_____ by:_____

2. Estimated Pre-burn Weight (wt): _____kg (Average Service Members are 82 ± 15 kg)

3. Estimate Total Burn Surface Area (TBSA) using Rule of Nines (refine with Lund-Browder after wounds are cleansed)

Partial thickness (2nd)_____% + Full thickness (3rd)_____% = **TBSA**_____%

IF TBSA >40%: intubate (use ETT ≥ 7.5 fr to facilitate bronchoscopy)

IF TBSA <15%: formal resuscitation may not be required, provide maintenance and/or oral fluids

4. Standard Burn Resuscitation Fluid: Lactated Ringers (LR) or Plasmalyte

5. Calculate INITIAL Fluid Rate using Rule of 10 (adults):

- IF wt < 40kg: 2ml x %TBSA_____ x wt(kg)_____ ÷ 16 = _____ml/hr
- IF wt ≥ 40kg: %TBSA_____ x 10 = _____ml/hr
  - IF wt > 80kg: add 100ml/hr to initial rate for every 10 kg>80: adjusted initial fluid rate = _____ml/hr
  - (Example: 100kg patient with 50% TBSA burn = 50% x 10 = 500 ml + 200 ml = 700 ml for first hour)

6. If Inhalation Injury Present: administer aerosolized heparin in albuterol (5,000 units Q4 hours)

7. Titrate Resuscitation Fluid: maintain target **UOP 30-50ml/hr** (Q 1 hour)

- If rhabdomyolysis present: use target UOP 75-100 ml/hr (Contact USAISR Burn Center DSN 312-429-2876)
- Goals: UOP >30 but <50ml/hr; adequate tissue perfusion (normalized lactate/base deficit), MAP >55 mmHg
- Minimum fluid rate 125mL/hr LR
- * Avoid fluid boluses
- ** Too much fluid as dangerous as too little

High risk for over resuscitation/abdominal compartment syndrome:

- If hourly rate >1500mL/hr x 2 hrs OR
- If total 24 hr volume exceeds: wt(kg) x 250ml= _____ml (includes all infused fluids)
  - Contact USAISR Burn Center (DSN 312-429-2876)
  - Consider adjuncts (below)
  - Check bladder pressures Q4hrs (>20 mmHg notify physician)
  - Avoid surgical decompression (significant mortality risk in burns)

Adjuncts:

1. Colloids: 5% albumin/FFP (Hextend only if others unavailable)
   - * Colloids not preferred until hour 8-12; can consider earlier in difficult resuscitation
   - Infuse at ml/hr according to chart below based on adult patient weight and burn size
2. Vasopressors: Contact USAISR Burn Center (DSN 312-429-2876)

5% Albumin Infusion (ml/hr)	30-49%TBSA	50-69% TBSA	70-100% TBSA
<70 kg	30	70	110
70-90 kg	40	80	140
>90 kg	50	90	160

Ensure adequate volume (CVP trend 6-8 cm H_2O); **maintain MAP > 55 mmHg**

JTS BURN RESUSCITATION WORKSHEET

- Maintain ionized Ca >1.1 mmol/L
- Start with vasopressin 0.04mg/min. **DO NOT TITRATE**
- Second line pressor: norepinepherine 2-20mcg/min
- Refractory shock: consider epinephrine or phenylephrine infusion
- Refractory shock: consider adrenal insufficiency, give hydrocortisone 100mg IV Q8 hrs
- Manage acidemia (pH<7.2): use ventilator interventions first, then bicarbonate or THAM infusion
- Renal replacement therapy if available (Contact USAISR Burn Center DSN 312-429-2876)

Assessment/Interventions:

- Complete full secondary trauma exam
- Ensure thermoregulation; administer warmed fluids; cover with space blanket; elevate burned extremities
- Superficial burn (1st degree): Sunburn, no blister, blanch readily; NOT included in TBSA
- Partial thickness (2nd degree): Blanch, moist, blisters, sensate
- Full thickness (3rd degree): Leathery, white, non-blanching, dry, insensate, thrombosed vessels
- Protect eyes with moisture shields if corneas exposed or blink reflex slow; apply ophthalmic erythromycin ointment at least Q2hrs.
- **Prompt intubation for facial burns, suspected inhalation injury, TBSA >40%**
    - Anticipate induction-associated hypotension
    - Secure ETT with cloth tie, not adhesive tape
    - Reassess ETT position at teeth Q1 hr as edema develops and resolves
    - Intubated patients require oro/naso-gastric tube for decompression
    - Administer IV proton-pump inhibitor
- Monitor bladder pressure at least Q4hrs for large burns or high volume resuscitations
    - Abdominal compartment syndrome: decreased UOP, increased pulmonary pressures, difficulty ventilating, bladder pressure remains > 20 mmHg
    - Avoid decompressive laparotomy; consider percutaneous peritoneal drainage
    - Reduce crystalloid volume using colloid or vasopressors
- Monitor pulses hourly: palmar arch, dorsalis pedis, posterior tibial with Doppler
    - Consider escharotomy if signal diminished; refer to Burn CPG for technique (Call USAISR Burn Center DSN 312-429-2876)
- Monitor extremity compartment pressures as clinically indicated
    - Elevate burned extremities at all times
    - Extremity compartment syndrome: pain, paresthesia, pallor, paralysis, pulselessness (late sign)
    - Fasciotomy may be required
- Wound care
    - Thoroughly cleanse burn wounds, preferably in Operating Room
    - Select topical antimicrobial in consultation with Burn Surgeon (Call USAISR Burn Center DSN 312-429-2876) based on product availability, expected transport time, etc
    - Acceptable to cover burns with dry sheets or clean dressings for first 48 hours
- All definitive burn surgery done at USAISR Burn Center for US Service Members (DSN 312-429-2876)

JTS Burn Resuscitation Flow Sheet – page 1 of 3

Date		Initial Treatment Facility					
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary	
Date &Time of Injury				BAMC/ISR Burn Team DSN (210) 916-BURN: Yes No			

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	1st								
	2nd								
	3rd								
	4th								
	5th								
	6th								
	7th								
	8th								
	9th								
	10th								
	11th								
	12th								
	13th								
	14th								
	15th								
	16th								
	17th								
	18th								
	19th								
	20th								
Total Fluids:									

*Titrate LR hourly to maintain adequate UOP (30-50ml/hr) and perfusion

JTS Burn Resuscitation Flow Sheet – page 2 of 3

Date		Initial Treatment Facility					
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary	
Date &Time of Injury				BAMC/ISR Burn Team DSN 312-429-2876: Yes No			

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	25th								
	26th								
	27th								
	28th								
	29th								
	30th								
	31st								
	32nd								
	33rd								
	34th								
	35th								
	36th								
	37th								
	38th								
	39th								
	40th								
	41st								
	42nd								
	43rd								
	44th								
	45th								
	46th								
	47th								
	48th								
Total Fluids:					*Titrate LR hourly to maintain adequate UOP (30-50ml/hr) and perfusion				

JTS Burn Resuscitation Flow Sheet – page 3 of 3

Date		Initial Treatment Facility					
Name		SSN	Pre-burn estimated weight (kg)	%TBSA (Do not include superficial 1st degree burn)	Calculate Rule of Tens (if >40<80kg, %TBSA x 10 = starting rate for LR	Calculate max 24hr volume (250ml x kg) Avoid over-resuscitation, use adjuncts if necessary	
Date &Time of Injury				BAMC/ISR Burn Team DSN 312-429-2876: Yes No			

Tx Site/ Team	HR from burn	Local Time	Crystalloid* (LR) / Colloid	Total	UOP (Target 30-50ml/hr)	Base Deficit/ Lactate	Heart Rate	MAP (>55) / CVP (6-8mmHg)	Pressors (Vasopressin 0.04 u/min) Bladder Pressure (Q4)
	49th								
	50th								
	51st								
	52nd								
	53rd								
	54th								
	55th								
	56th								
	57th								
	58th								
	59th								
	60th								
	61st								
	62nd								
	63rd								
	64th								
	65th								
	66th								
	67th								
	68th								
	69th								
	70th								
	71st								
	72nd								
Total Fluids:					*Titrate LR hourly to maintain adequate UOP (30-50ml/hr) and perfusion				

DA Form 4700, Evacuation Patient Care Record (PCR)

1. **BACKGROUND and PURPOSE**
   a. Pre-Hospital, Pre-Medical Treatment Facility (pre-MTF), or inter-MTF evacuation documentation of medical interventions by ground vehicle and rotary-wing based medical personnel (CASEVAC/MEDEVAC) is critical to ensuring continuity of care and providing meaningful analyses of medical interventions, techniques, tactics, and procedures rendered during transport.
   b. As medical providers, it is critically important to document patient care for follow on providers in order to achieve the best patient outcomes. Additionally, well documented care can improve not only individual care, but as part of a Process Improvement system, good documentation can identify places where casualty care can be improved on a system-wide level.
   c. Use of the DA Form 4700, Evacuation Patient Care Record (PCR) will allow for individual care improvement as well as a method to enable appropriate patient care documentation. This will enable process improvement and quality assurance for medical providers rendering care during patient evacuations. It is designed specifically for documentation of care for all patients transported via ground or rotary-wing platforms in order to document all evaluation and care provided for casualties.

2. **POLICY**
   a. Commanders will ensure that all providers evacuating patients (to include both deployed and garrison operations, regardless of AOR) use the PCR to document enroute care. Such care relates to both battle and non-battle injuries.
   b. Once completed, the PCR will be entered into the patient's medical record and the Department of Defense Trauma Registry (DoDTR). Evacuation unit commanders must establish a clear process to ensure transmission of the medical information recorded to the Joint Trauma System for data capture and entry into both the patients' medical record and the DoDTR.
   c. Medical personnel providing care during evacuation will complete all entries as fully as possible.
   d. All abbreviations authorized for use in DoD health records or DoD trauma registries may also be used on the PCR.
   e. This PCR can be completed manually or electronically after care is provided and is designed to work equally well for either. Manual entries may be made using a non-smearing pen or marker.
   f. Free-text may be entered in any block despite appearance of drop-down menus.
   g. Blocks where information is not applicable should be left blank or can be marked "N/A"
   h. In an effort to accurately capture all patient care delivered, providers can document treatments relevant to their transport performed by personnel prior to their assumption of patient care. This care should be documented in the appropriate locations on the form with the time marked as "PTA" (Prior to arrival). (Ex: Ground medic places TQ on RUE prior to MEDEVAC arrival. TQ location, type, etc. should be annotated with time as "PTA").
   i. This form should be completed within 72 hours upon completion of evacuation mission and submitted to JTS ASAP following Medical Director review. Forms can be submitted via NIPR e-mail to: DHA.JBSA.j-3.List.JTS-Prehospital@mail.mil

   j. Additionaly JTS has the Military Enroute Care Registry (MERCuRY) (army.mil). Performance Improvement Events Data worksheet. See instructions on worksheet. Complete the MERCuRY worksheet in conjunction with the DA 4700 before submitting to the Joint Trauma System. (https://jts.amedd.army.mil/assets/docs/forms/MERCuRY_PI_28_Oct_2021.pd)

3. The most current version of the form, along with instructions for use can be found on the JTS site under the documents tab, or at the following address:
   https://jts.amedd.army.mil/index.cfm/documents/forms_after_action

MEDICAL RECORD-SUPPLEMENTAL MEDICAL DATA

For use of this form, see AR 40-66; the proponent agency is the Office of the Surgeon General

REPORT TITLE

Tactical Evacuation After Action Report & Patient Care Record, *Page 1*

JTS APPROVED *(Date)* *(12 Jul 2018) -V4.1*

Event: Date _____ Time _____ Time Zone ◯L ◯Z | MM (___) _____ | Pt # ___ of ___ | Tail to Tail ◯Y ◯N | Leg # ___ of ___

9-Line: Time _____ Platform _____ Dispatch Cat _____ Assessed Cat _____

Trauma MIST Report: *M=Mechanism of Injury, I=Injury, S=Signs & Symptoms, T=Treatments* / **Disease Diagnosis:** _____

M _____ I _____ S _____ T _____

Comments _____

Pickup: Time _____ Role _____ Other _____ Region _____ Other _____ Location _____

Dropoff: Time _____ Role _____ Other _____ Region _____ Other _____ Location _____

Capability ☐ EMT-B ☐ EMT-I ☐ EMT-P ☐ EMT-FPC ☐ RN ☐ CRNA ☐ PA ☐ MD/DO Other _____

Circulation-Hemorrhage Control

☐ Direct Pressure
☐ Hemostatic Dressing
☐ Kerlix Dressing
☐ Pressure Dressing
Other _____

Tourniquet
Prior TQ: Reassess/tighten
◯ Y ◯ N ◯ N/A

Time On ___ ☐ CAT ☐ SOFTT ☐ Other _____ ☐ RUE ☐ LUE ☐ RLE ☐ LLE # ___
Time On ___ ☐ CAT ☐ SOFTT ☐ Other _____ ☐ RUE ☐ LUE ☐ RLE ☐ LLE # ___
Time On ___ ☐ CAT ☐ SOFTT ☐ Other _____ ☐ RUE ☐ LUE ☐ RLE ☐ LLE # ___
Time On ___ ☐ CAT ☐ SOFTT ☐ Other _____ ☐ RUE ☐ LUE ☐ RLE ☐ LLE # ___
Time On ___ ☐ AAJT ☐ CRoC ☐ JETT ☐ SAM ☐ Other Junctional _____ # ___

TQ Comments _____

Airway

☐ Self ☐ NPA ☐ OPA ☐ Cric ☐ Trach ☐ ETT ☐ SGA Type _____

Tube Size _____ Pos ___ @ _____ Confirmed ☐BS ☐ Vis ☐ $ETCO_2$

O_2 Source ☐ NC ☐ NRB ☐ BVM ☐ Vent LPM _____

Intubated ☐ Prior to transport ☐ By transport crew **Suction** ☐ ETT ☐ Yaunker

Breathing

Needle Decompression

Time ___ ☐ R ☐ L ☐ Mid-ax ☐ Mid-clav
Time ___ ☐ R ☐ L ☐ Mid-ax ☐ Mid-clav
Time ___ ☐ R ☐ L ☐ Mid-ax ☐ Mid-clav
Time ___ ☐ R ☐ L ☐ Mid-ax ☐ Mid-clav

Chest Tube Time ___ ☐ R ☐ L

Chest Equal Rise and Fall
◯ Y ◯ N ◯ N/A

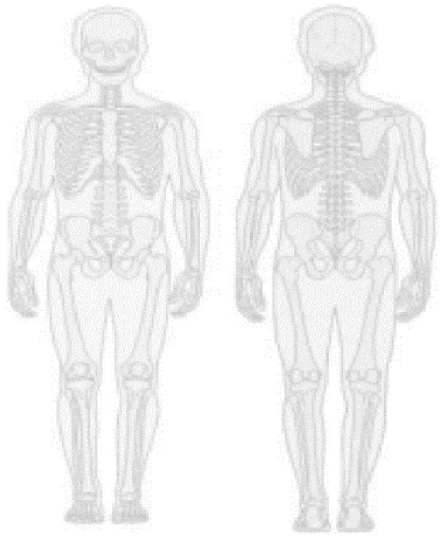
Respiratory Effort
☐ Unlabored ☐ Labored
☐ Agonal ☐ Assisted

Vent Settings

	Time	Mode	Rate	TV	FiO_2	PEEP	PIP	$ETCO_2$
Initial								
Change								
Change								
Change								

Annotate Injuries

(AMP)utation
(BL)eeding
(B)urn % TBSA ___
(C)repitus
(D)eformity
(DG)Degloving
(E)cchymosis
(FX)Fracture
(GSW)Gunshot Wound
(H)ematoma
(IMP)Impaled Object
(LAC)eration
(P)ain
(PP)Peppering
(PW)Puncture Wound
(SQA)Subcutaneous Air
(TBI)Suspect
Other _____



Circulation - Assessment

Rhythm / Ectopy
☐ NSR ☐ SVT
☐ ST ☐ VT
☐ SB ☐ VF
☐ PEA
☐ Paced
☐ Asystole
☐ A-FIB
☐ A-FLUT

Pulses
A, D, +1, +2, +3
RAD ___
BRAC ___
CAR ___
FEM ___
PED ___
TEMP ___

Circulation - Resuscitation

Transfusion Indication
☐ Amputation
☐ HR > 120
☐ SBP < 90

Blood Infusion

Time	Component	ABO/RH	Unit Number	Exp. Date	Blood Age

IV Lines

Peripheral
Hand ☐ R ☐ L ga ___
Arm ☐ R ☐ L ga ___
EJ ☐ R ☐ L ga ___

IO Type / Site
☐ Fast-1 ☐ EZ IO Other _____
Humerus ☐ R ☐ L
Tibia ☐ R ☐ L
☐ Sternum

Central Line Location
☐ Triple lumen _____
☐ Cordis _____

Arterial Line
Wrist ☐ R ☐ L
Groin ☐ R ☐ L

PREPARED BY *(Name, Rank & Title)* | DEPARTMENT/SERVICE/CLINIC *(Treating Unit)* | DATE

PATIENT'S IDENTIFICATION (*Name: last, first, middle; grade; date; hospital or medical facility)*

Last Name _____ First Name _____ MI ___

BR# _____ Rank _____ Unit _____ Pt Cat _____

SSN _____ DOB _____ Gender ◯ M ◯ F Allergy _____ Other _____

☐ HISTORY/PHYSICAL ☒ TREATMENT
☐ DIAGNOSTIC STUDIES ☐ FLOW CHART
☐ OTHER EXAMINATION OR EVALUATION
☐ OTHER, Specify

MEDICAL RECORD-SUPPLEMENTAL MEDICAL DATA

For use of this form, see AR 40-66; the proponent agency is the Office of the Surgeon General

REPORT TITLE

Tactical Evacuation After Action Report & Patient Care Record, *Page 2*

JTS APPROVED *(Date)*
(12 Jul 2018) -V4.1

Vital Signs

	Time	HR	BP	RR	SpO_2	$ETCO_2$	Temp	F	C	AVPU	GCS: Eyes 1-4	Verbal 1-5	Motor 1-6	Total	Pain 0-10
First			/					○	○						
			/					○	○						
			/					○	○						
Last			/					○	○						

PERRLA ☐ R Size (mm) _____ ☐ L Size (mm) _____

Field Ultrasound Results _____ Other Diagnostics _____

Additional Interventions

	Time		Time	
Foley	_____	Comment _____	**Gastric Tube**	_____ ☐ Oral ☐ Nasal Comment _____
Protection	_____	☐ Eye Shield ☐ Protective Eyewear ☐ Right ☐ Left Comment _____		
Immobilization	_____	☐ C-Collar ☐ C-Spine ☐ Spine Board ☐ Pelvic Splint ☐ Pelvic Binder, Type _____		
	_____	☐ Splint, Type/Location _____		
Warming	_____	☐ Hypothermia Prevention, Product _____		
	_____	☐ Hypothermia Prevention, Product _____		
Other Interventions	_____	_____		
	_____	_____		

Medications and Fluids *Route = IM, IN, IO, IV, PO, PR, SL, SQ*

Time	Drug / Fluid	Dose	Route

Medications and Fluids *Route = IM, IN, IO, IV, PO, PR, SL, SQ*

Time	Drug / Fluid	Dose	Route

Documents Received ☐ TCCC Card ☐ Patient Chart ☐ None Other _____

Narrative Summary of Care

Enroute Care Provider

Last Name	First Name	Rank	Capability	Signature

Email PCR to: DHA.JBSA.J-3.List.JTS-Prehospital@mail.mil **MM (** ___ **)** _____

PREPARED BY *(Signature & Title)*	DEPARTMENT/SERVICE/CLINIC *(Treating Unit)*	DATE

PATIENT'S IDENTIFICATION (*Name: last, first, middle; grade; date; hospital or medical facility)*

Last Name _____ First Name _____ MI ___

BR# _____ Rank _____ Unit _____ Pt Cat _____

SSN _____ DOB _____ Gender ○ M ○ F Allergy _____ Other _____

☐ HISTORY/PHYSICAL ☒ TREATMENT
☐ DIAGNOSTIC STUDIES ☐ FLOW CHART
☐ OTHER EXAMINATION OR EVALUATION
☐ OTHER, Specify

TACTICAL EVACUATION-AFTER ACTION REPORT & PATIENT CARE RECORD

IAW AR 40-68 (RAR) 22 May 2009 Paragraph 3–7. This page is a quality assurance document. Do not file in medical records.

Casualty's Protective Equipment *(Check all worn)*

☐ Helmet, Ballistic	☐ Plate Front	☐ Neck Protector *(Back)*	☐ Groin Shield	☐ Blast Gauge
☐ Tactical Vest *(IOTV)*	☐ Plate Back	☐ Throat Protector *(Front)*	☐ Pelvic Undergarment Tier 1	☐ Blast Sensor Helmet
☐ Eye Protection	☐ Plate Right Side	☐ Deltoid Right	☐ Pelvic Undergarment Tier 2	☐ Blast Sensor Other
☐ Ear Protection	☐ Plate Left Side	☐ Deltoid Left		

AAR Discussion Event Date _____ ☐ Tactical situation complicated care *(Explain in discussion)*

Sustains	Improves

PATIENT'S IDENTIFICATION (*Name: last, first, middle; grade; date; hospital or medical facility)*

Last Name _____ First Name _____ MI ____

BR# _____ Rank _____ Unit _____

SSN _____ DOB _____ Gender ◯ M ◯ F Pt Cat _____

Date _____ Allergy _____ Other _____

The *National Defense Authorization Act* for fiscal year 1987 (Public Law (PL) No. 99-661), section 1102, Title 10, (10USC 1102) this document was created by or for the DOD in a medical QA program and is confidential and privileged. PL 99-661 and subsequent guidance predicated on this law (10 USC 1102) preclude disclosure of, or testimony about, any records or findings, recommendations, evaluations, opinions, or actions taken as part of a QA program except in limited situations. Under the provisions of 10 USC 1102, this information is exempt from release in accordance with Exemption 3 of the FOIA. Additional detailed information regarding the confidentiality of QA documents and records is contained in appendix B.

Military Enroute Care Registry (MERCuRY)

Performance Improvement Event(s) Data

Joint Trauma System, Version 1.1, 28 Oct 2021

Last Name | First Name | Date

PSSN/SSN | ☐ PSSN ☐ SSN

Mission # | Mission Leg #

Documentation

- ☐ Standard form not used
- ☐ Patient identification not completed
- ☐ Dispatched versus assessed category differ
  - ☐ Dispatched category higher than assessed
  - ☐ Dispatched category lower than assessed
- ☐ MIST report mechanism not correct
- ☐ MIST report injuries not correct
- ☐ Mission times not recorded
  - ☐ Pick up time not recorded
  - ☐ Drop off time not recorded
  - ☐ Both times not recorded
- ☐ Role of care not documented
  - ☐ Pick up not recorded
  - ☐ Drop off not recorded
  - ☐ Both not recorded
  - ☐ POI mission
  - ☐ Transfer mission

Circulation /Hemorrhage Control

- ☐ Tourniquet not placed when indicated
- ☐ Tourniquet not reassessed
- ☐ Tourniquet conversion not attempted when indicated
- ☐ Tourniquet time not recorded
- ☐ Tourniquet indicated and successfully performed
- ☐ Type of tourniquet
  - ☐ Limb
  - ☐ Junctional

Airway

- ☐ Deviation from airway management protocol
- ☐ Advanced non-surgical airway placement
  - ☐ Indicated and successfully performed
  - ☐ Performed when not indicated
  - ☐ Not performed when not indicated
  - ☐ Attempted unsuccessfully
- ☐ Cricothyroidotomy
  - ☐ Indicated and successfully performed
  - ☐ Performed when not indicated
  - ☐ Not performed when indicated
  - ☐ Attempted unsuccessfully

Breathing

- ☐ Needle decompression
  - ☐ Indicated and successfully performed
  - ☐ Performed but respiratory distress not resolved
  - ☐ Performed when not indicated
  - ☐ Two or more on the same side
  - ☐ Site not recorded
- ☐ Thoracostomy - finger or tube
  - ☐ Indicated and successfully performed
  - ☐ Performed when not indicated
  - ☐ Not performed when indicated
  - ☐ Attempted unsuccessfully
  - ☐ Two or more on the same side
- ☐ Ventilator management, no ETCO2 recorded
- ☐ Deviation from ventilator management protocol
- ☐ Vent setting changed but no outcome recorded
- ☐ Unplanned extubation enroute

Circulation

- ☐ Rhythm not recorded
- ☐ Blood product transfusion protocol
  - ☐ Indicated and successfully performed
  - ☐ Performed when not indicated
  - ☐ Not performed when indicated
  - ☐ Capability not available
- ☐ IV/IO not inserted enroute when indicated
- ☐ IV/IO insertion unsuccessful
- ☐ Tube or line dislodged enroute

Vitals

- ☐ Appropriate level of monitoring not utilized
- ☐ Vital signs not documented
  - ☐ Blood pressure
  - ☐ Heart rate
  - ☐ Respiratory rate
  - ☐ Sa02
  - ☐ Temperature
- ☐ Hypoxia (SaO2<88%)
  - ☐ Indicated intervention for hypoxia not performed
- ☐ Hypotension (SBP<90 mmHg)
  - ☐ Indicated intervention for hypotension not performed
- ☐ GCS or AVPU not documented
- ☐ GCS or AVPU changes not documented
- ☐ Pain assessment not completed

Additional Interventions

- ☐ Immobilization not performed when indicated
  - ☐ C-collar
  - ☐ Pelvic binder
  - ☐ Spinal motion restriction
  - ☐ SAM splint for extremity
  - ☐ Rigid eye shield
- ☐ Hypothermia prevention not initiated when indicated

Medications

- ☐ Pain medication not given per protocol
- ☐ Pain medication given, outcome undocumented
- ☐ TXA not given <3 hrs after injury when indicated
- ☐ Antibiotic not given per protocol
- ☐ Other medication delay or complication (please specify)

Notes

Other

- ☐ Documentation from sending provider did not accompany patient (TCCC card or patient chart)
  - ☐ Absent documentation from ground team
- ☐ Diversion of flight or unplanned destination
- ☐ Incomplete hand off from ground team
- ☐ Equipment problem, unable to be resolved enroute
- ☐ Environmental issues affecting patient outcome
- ☐ Death or CPR enroute
- ☐ Missing needed gear or medications
- ☐ Events enroute precluding adequate patient monitoring/assessment/treatment
- ☐ Other (please specify in Notes)

Notes & Comments

Instructions

1. Complete the Mercury in conjunction with the 4700 before submitting to the Joint Trauma System.
2. Enroute care should be assessed for compliance with standard guidelines to include: Tactical Combat Casualty Care guidelines, Standard Medical Operating Guidelines, JTS Intratheater transport clinical practice guide.
3. At least two unique patient identifiers are needed for documenting patient identification.
4. One identifier must be last name, BR#, or SSN. The second identifier can be first name, BR#, SSN, DOB, or unit.
5. Hemorrhage control, Airway, Breathing, Circulation, Vitals, Additional Interventions, Medications: Evaluate enroute interventions only. Do not evaluate interventions performed prior to MEDEVAC.
6. Other-incomplete handoff from ground team: Review narrative for comments relating to incomplete or inadequate handoff.

INSTRUCTIONS: DD Form 1380, Tactical Combat Casualty Care (TCCC) Card
[Formerly: U.S. Field Medical Card]

1. BACKGROUND and PURPOSE

a. Pre-Hospital or Pre-Medical Treatment Facility (pre-MTF) documentation of medical interventions by first responders at the point of injury (POI) is critical to ensuring continuity of care and providing meaningful analyses of medical interventions, techniques, tactics, and procedures rendered at the POI.

b. In a deployed, combat, or training setting, all personnel have the potential to be casualties and all personnel have the potential to be first responders.

c. In accordance with Joint Publication 4-02, Health Service Support, dated 26 July 2012: "First responder care capability is also known as tactical combat casualty care. Tactical combat casualty care [or TCCC] occurs during a combat mission and is the military counterpart to pre-hospital trauma life support. Pre-hospital trauma care in the military is most commonly provided by enlisted personnel and includes self-aid and buddy aid and combat life savers.... Tactical combat casualty care focuses on the most likely threats, injuries, and conditions encountered in combat and on a strictly limited range of interventions directed at the most serious of these threats and conditions...."

d. DD Form 1380 promotes Department of Defense goals of capturing documentation of pre-MTF medical interventions at the POI using a MIST format (Mechanisms of injury; Injuries; Signs & Symptoms; and Treatments). It is designed for use by all first responders, including non-medical personnel.

2. POLICY

a. Commanders will ensure that all first responders carry and use DD Form 1380 to document pre-MTF care at the POI. Such care relates to both battle and non-battle injuries.

b. Once completed, DD Form 1380 must be visibly attached to the patient. Upon arrival at a Role 2 or Role β MTF, DD Form 1380 will be included with the paper medical record, then scanned and entered into both the patient's electronic health record and the trauma system's trauma registry. Role 2 and Role 3 MTF commanders must establish a clear process to ensure entry of the medical information recorded on DD Form 1380 into the both the electronic health record and the trauma registry.

c. DD Form 1380 will be a component of the individual/improved first aid kit (IFAK), joint first aid kit (JFAK), and other first aid kits utilized. Corpsmen, combat medics, and tactical evacuation personnel should carry multiple blank versions of the form.

d. First responders will complete all entries as fully as possible on the DD Form 1380 unless under extreme conditions whereby the casualty and/or provider's safety may be at additional risk.

e. Detailed instructions for preparing DD Form 1380 are provided in Table 1 and Table 2.

f. All abbreviations authorized for use in DoD health records or DoD trauma registries may also be used on DD Form 1380.

g. All entries on the DD Form 1380 will be made using a non-smearing pen or marker.

h. All entries on the DD Form 1380 should be printed clearly, including the first responder's name.

Table 1: Instructions for completing DD Form 1380 (Front of Card)

Item	Instructions
Battle Roster #	Write first letter of casualty's first name, then first letter of casualty's last name, then write the last four numbers of casualty's Social Security number. For example, John Doe 123-12-1234 is Battle Roster # "JD1234".
Evacuation (EVAC)	Mark an "X" on the casualty's evacuation priority/precedence (Urgent; Priority; or Routine).
Name	Write casualty's name (Last, First).
Last 4	Write last four numbers of casualty's Social Security number.
Gender	Mark an "X" on the casualty's gender (Male (M) or Female (F)).
Date	Write date of injury in DD-MMM-YY format. For example, "29-JUN-13".
Time	Write 24 hour time of injury, and indicate whether local (L) or zulu (Z) time. For example, "1300Z".
Service	Write casualty's branch of service (USA, USAF, USCG, USN, USMC). For U.S. civilians, write "US CIV". For non-U.S. personnel, write "NON US or a standard abbreviation for casualty's nationality.
Unit	Write casualty's unit name.
Allergies	Write casualty's known drug allergies. If no drug allergies, write "NKDA" (no known drug allergies).
Mechanism of Injury	Mark an "X" on the mechanism or cause of injury (artillery, blunt, burn, fall, grenade, gunshot wound (GSW), improvised explosive device (IED), landmine,

INSTRUCTIONS: DD Form 1380, Tactical Combat Casualty Care (TCCC) Card
[Formerly: U.S. Field Medical Card]

Item	Instructions
	motor vehicle crash/collision (MVC), rocket-propelled grenade (RPG), other (specify)). Mark all that apply.
Injury	Mark an "X" at the site of the injury(ies) on the body picture. For burn injuries, circle the burn percentage(s) on the figure. If multiple mechanisms of injury and multiple injuries, draw a line between the mechanism of injury and the anatomical site of the injury.
TQ: R Arm (tourniquet, right arm)	If a tourniquet is applied to the right arm, write type of tourniquet used and the time of tourniquet application.
TQ: L Arm (tourniquet, left arm)	If a tourniquet is applied to the left arm, write type of tourniquet used and the time of tourniquet application.
TQ: R Leg (tourniquet, right leg)	If a tourniquet is applied to the right leg, write type of tourniquet used and the time of tourniquet application.
TQ: L Leg (tourniquet, left leg)	If a tourniquet is applied to the left leg, write type of tourniquet used and the time of tourniquet application.
Time, Pulse (rate & location), Blood Pressure, Respiratory Rate, Pulse Ox % O2 Sat, AVPU, Pain Scale (0-10)	Record vital signs (pulse rate and location, blood pressure, respiratory rate, oxygen saturation), level of consciousness (AVPU: Alert, responds to Verbal stimulus, responds to Pain stimulus, Unresponsive), and level of pain (on numeric rating scale of 0 to 10, with 0 being no pain and 10 being the worst pain) with time.

Table 2: Instructions for completing DD Form 1380 (Back of Card)

Item	Instructions
Battle Roster #	Write first letter of casualty's first name, then first letter of casualty's last name, and then write the last four numbers of casualty's Social Security number. For example, John Doe 123-12-1234 is Battle Roster # "JD1234".
Evacuation (EVAC)	Mark an "X" on the casualty's evacuation priority/precedence (Urgent; Priority; or Routine).
C	Mark an "X" for all Circulation hemorrhage control interventions. For tourniquets (TQ), mark category (Extremity, Junctional and/or Truncal) and write name of TQ(s) used. For dressings, mark category (Hemostatic, Pressure, and/or Other) and write type of dressing(s) used.
A	Mark an "X" for all Airway interventions (Intact, NPA (nasopharyngeal airway), CRIC (cricothyroidotomy), ET Tube (endotracheal tube), SGA (supraglottic airway) and write type of device(s) used.
B	Mark an "X" for all Breathing interventions (O2 (oxygen), Needle-D (needle decompression), Chest-Tube, Chest-Seal) and write type of device(s) used.
C: Fluid	Circulation resuscitation interventions. Write name, volume, route, and time of any fluids given.
C: Blood Product	Circulation resuscitation interventions. Write name, volume, route, and time of any blood products given.
Meds: Analgesic	Medications. Write name, dose, route, and time of any analgesics given.
Meds: Antibiotic	Medications. Write name, dose, route, and time of any antibiotics given.
Meds: Other	Medications. Write name, dose, route, and time of any other administered medications.
Other	Mark an "X" for other treatments administered (combat pill pack, eye shield (mark right (R) or left (L)), splint, hypothermia prevention) and type of device(s) used.
Notes	Use this space to record any other pertinent information and/or clarifications.
First Responder Name	Print the first responder's name (Last, First).
First Responder Last 4	Write last four numbers of first responder's Social Security number.

3. **ISSUANCES**
   a. DoDI 6490.02E, Comprehensive Health Surveillance
   b. DoDI 6040.45, Service Treatment Record (ST) and Non-Service Treatment Records (NSTR)
   c. DHB Memorandum Battlefield Trauma Care RDT&E Priorities 2011-01 (June 14, 2011)
   d. AR 40-66, Medical Record Administration and Healthcare Documentation

TACTICAL COMBAT CASUALTY CARE (TCCC) CARD

BATTLE ROSTER #: _____

EVAC: ☐ **Urgent** ☐ **Priority** ☐ **Routine**

NAME (Last, First): _____ **LAST 4:** _____

GENDER: ☐ **M** ☐ **F** **DATE** (DD-MMM-YY): _____ **TIME:** _____

SERVICE: _____ **UNIT:** _____ **ALLERGIES:** _____

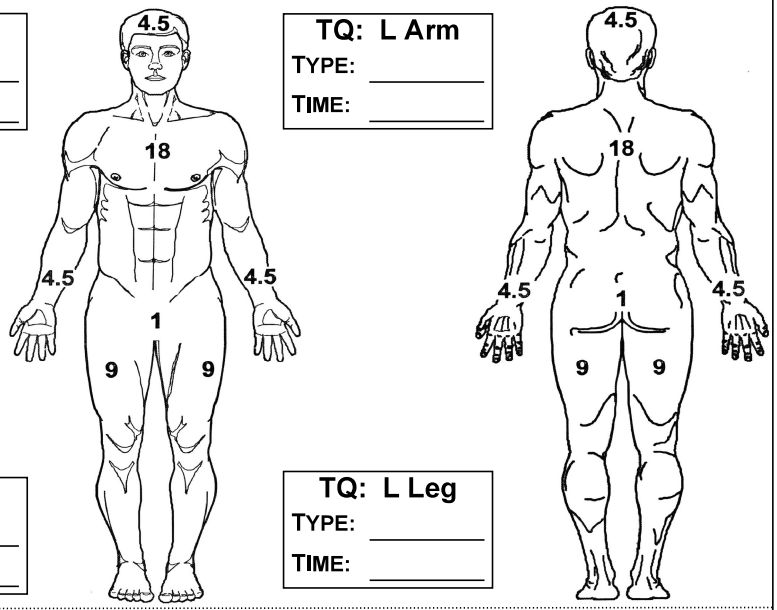
Mechanism of Injury: (X all that apply)

☐ **Artillery** ☐ **Blunt** ☐ **Burn** ☐ **Fall** ☐ **Grenade** ☐ **GSW** ☐ **IED**
☐ **Landmine** ☐ **MVC** ☐ **RPG** ☐ **Other:** _____

Injury: (Mark injuries with an **X**)

TQ: R Arm
TYPE: _____
TIME: _____

TQ: L Arm
TYPE: _____
TIME: _____



TQ: R Leg
TYPE: _____
TIME: _____

TQ: L Leg
TYPE: _____
TIME: _____

Signs & Symptoms: (Fill in the blank)

Time				
***Pulse** (Rate & Location)*				
Blood Pressure	/	/	/	/
Respiratory Rate				
Pulse Ox % O2 Sat				
AVPU				
***Pain Scale** (0-10)*				

DD Form 1380, JUN 2014 **TCCC CARD**

BATTLE ROSTER #: _____

EVAC: ☐ Urgent ☐ Priority ☐ Routine

Treatments: (X all that apply, and fill in the blank) *Type*

C: TQ- ☐ Extremity ☐ Junctional ☐ Truncal _____

Dressing- ☐ Hemostatic ☐ Pressure ☐ Other _____

A: ☐ Intact ☐ NPA ☐ CRIC ☐ ET-Tube ☐ SGA _____

B: ☐ O2 ☐ Needle-D ☐ Chest-Tube ☐ Chest-Seal _____

C:	*Name*	*Volume*	*Route*	*Time*
Fluid				
Blood Product				

MEDS:	*Name*	*Dose*	*Route*	*Time*
Analgesic (e.g., Ketamine, Fentanyl, Morphine)				
Antibiotic (e.g., Moxifloxacin, Ertapenem)				
Other (e.g., TXA)				

OTHER: ☐ Combat-Pill-Pack ☐ Eye-Shield (☐ R ☐ L) ☐ Splint

☐ Hypothermia-Prevention Type: _____

NOTES:

FIRST RESPONDER

NAME (Last, First): _____ LAST 4: _____

DD Form 1380, JUN 2014 (Back) TCCC CARD

TACTICAL COMBAT CASUALTY CARE AFTER ACTION REPORT (TCCC AAR)

Complete within 72hrs after mission and submit to the Joint Trauma System via email: DHA.JBSA.j-3.List.JTS-Prehospital@mail.mil

Event Date: _____ Time: _____ ☐ Local ☐ ZULU Country: _____ Theater _____

Injury ☐ Battle Injury (BI): ☐ WIA ☐ KIA ☐ DOW ☐ Non-Battle Injury (NBI): ☐ Alive ☐ Dead

Evacuation Category ☐ URG ☐ PRI ☐ ROU

☐ Litter Type: _____ Time of Pick Up: _____

☐ Ground Vehicle Type: _____ Time of Pick Up: _____

☐ Aircraft Type: _____ Time of Pick Up: _____

☐ Watercraft Type: _____ Time of Pick Up: _____

Casualty Demographics (mini. requirement:last name & last 4 SS# **Last Name:** _____ First Name: _____ Rank: _____

Gender ☐ M ☐ F **SSN/DoD ID:** _____ DOB: _____ Unit: _____ BR#: _____ Mission # _____

Point-of-Injury (POI) Provider Info

Non-Medic (NM) First Responder Last Name: _____ First Name: _____ Rank/Title: _____

Other POI Provider (OP) Last Name: _____ First Name: _____ Rank/Title: _____

Medic (M) Last Name: _____ First Name: _____ Rank/Title: _____

M - Mechanism of Injury

- ☐ Airborne Operation
- ☐ Aircraft Crash
- ☐ Blast – Dismounted IED or Mine
- ☐ Blast – Mounted IED or Mine
- ☐ Blast – RPG or Grenade
- ☐ Blast – Indirect Fire (Mortar/Artillery/Missile)
- ☐ Blast – Other
- ☐ Collapse/Crush/ Compartment from Structure
- ☐ Fire/Explosion
- ☐ Fall, Height: _____ ft
- ☐ Fragmentation / Shrapnel
- ☐ GSW – Gunshot Wound
- ☐ Vehicle Accident/Collision
- ☐ Environmental: _____
- ☐ Other: _____

I - Injuries

- ☐ (A)mputation
- ☐ (B)leeding
- ☐ (Bu)rn, TBSA: _____ %
- ☐ (C)repitus
- ☐ (D)eformity
- ☐ (DG)Degloving
- ☐ (E)cchymosis
- ☐ (FX)Fracture
- ☐ (GSW) Gun Shot Wound
- ☐ (H)ematoma
- ☐ (LAC)eration
- ☐ (P)ain
- ☐ (PP)Peppering
- ☐ (PW)Puncture Wound

Annotate Injuries

S - Signs

Initial Check Time _____

☐ A ☐ V ☐ P ☐ U GCS: _____ /15 (E _____ /4

V _____ /5, M _____ /6) RR: _____ HR: _____ BP: _____

pOx (%): _____ Pain level (_/10): _____ EtCO2 (mmHG): _____

Last Check Time _____

☐ A ☐ V ☐ P ☐ U GCS: _____ /15 (E _____ /4

V _____ /5, M _____ /6) RR: _____ HR: _____ BP: _____

pOx (%): _____ Pain level (_/10): _____ EtCO2 (mmHG): _____

Eye Opening - 4: spontaneous, 3: to speech, 2: to pain, 1: no response

Motor Response - 6: follows commands, 5: localizes pain, 4: withdraws from pain, 3: decorticate flexion, 2: decerebrate extension, 1: no response

Verbal Response - 5: alert and oriented, 4: disoriented conversation, 3: speaking but nonsensical, 2: moans, unintelligible sounds, 1: no response

T - Treatments

Massive Hemorrhage Control (TQ/Hemostatic Adjunct)

Time		Location		Type		Time off	
Time		Location		Type		Time off	
Time		Location		Type		Time off	
Time		Location		Type		Time off	

Airway

Time		Type		Size		Depth		@
Time		Type		Size		Depth		@
Time		Type		Size		Depth		@
Time		Type		Size		Depth		@

Respiration/Breathing ☐ Spontaneous ☐ Labored ☐ Assisted ☐ Assisted with BVM **Time**

☐ NM ☐ M ☐ OP ☐ Chest Seal Type: _____ _____

☐ NM ☐ M ☐ OP ☐ Needle Decompression Location ☐ 2ICS/MCL ☐ 5ICS/AAL # of attempts ___ Cath/Needle size _____ _____

☐ NM ☐ M ☐ OP ☐ Chest Tube ☐ Finger Thoracostomy ☐ Output ☐ Air Blood (ml) _____ _____

FORMS XIII

General instruction for Canine Trauma Combat Casualty Care Card

PURPOSE: The Canine Tactical Combat Casualty Care (cTCCC) card is for documenting a trauma or disease non-battle injury (DNBI) at the point of injury anywhere a canine is deployed in support of DoD operations. The cTCCC card will be filled out by the handler or provider who attends to the canine's trauma or DNBI. After medical treatment and resuscitation care is provided, the cTCCC card can be handed off to the nearest veterinary treatment facility or supporting veterinary unit to be scanned, uploaded and emailed to dog.consult@us.af.mil or the unit providing care can email directly. Once the MWD Trauma Registry is online, the first veterinary unit can input the information into the registry and scan the cTCCC card to upload into ROVR. The cTCCC card becomes part of the canine's permanent DoD medical record. For US Special Operations Command (SOCOM) canines, the cTCCC card will be filled out and returned to the handler or operator. The handler or operator will route the card to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.

PAGE 1:

GENERAL INSTRUCTIONS

- To be completed by the handler, human medical provider, veterinary technician or veterinarian fulfilling the role at the point of injury.
- Time Zones: Record all time local 24 hour military format, hh:mm
- A+ (plus sign) means positive test result; a - (minus sign) means negative test result.

EVACUATION CATEGORY (mark as appropriate)

URGENT – Patient who should be evacuated as soon as possible and within **two** hours to save life, limb or eyesight

PRIORITY – Patient who should be moved within **four** hours or their condition will deteriorate to such a degree that will be urgent

ROUTINE – Patient whose condition is not expected to worsen significantly and who will require evacuation in the next **24** hours

EVACUATION MODE & TYPE (mark as appropriate)

PATIENT IDENTIFICATION

UNIT. Record the unit the canine is assigned

ANIMAL NAME. (self-explanatory)

TATTOO. (self-explanatory)

DATE. (DD-MM-YY)

TIME. Record all time local 24 hour military format, hh:mm

GENDER. (mark as appropriate)

MECHANISM OF INJURY (mark as appropriate – use other for DNBI or if unknown – describe)

INJURY (mark the diagram where the trauma/injury or disease is located – if there are more than one injury, identify each with the mechanism of injury)

VITAL SIGNS (input vital signs at least hourly)

Pain Score:

0 – Pain free

1 – Very minor annoyance-occasional minor twinges

2 – Minor annoyance-occasional

3 – Annoying enough to be distracting

4 – Can be ignored if you are really involved in your work, but still distracting,

5 – Can't be ignored for more than 30 minutes.

6 – Can't be ignored for any length of time, but you can still go to work and participate in social activities.

7 – Make it difficult to concentrate, interferes with sleep, you can still function with effort

8 – Physical activity severely limited. You can read and converse with effort. Nausea and dizziness may occur.

9 – Unable to speak, crying out or moaning uncontrollable- pain makes you pass out

10 – Unconscious. Pain makes you pass out.

FIRST RESPONDERS (self-explanatory)

PAGE 2:

TREATMENTS (mark as appropriate) and annotate location where appropriate

M (Massive Hemorrhage): (mark as appropriate)

A (Airway Control): self-explanatory

R (Respiratory Support): self-explanatory

C (Circulation): FLUIDS (fill out as appropriate and complete as possible)

C (Fracture): self-explanatory

H (Hypo/hyperthermia): self-explanatory

H (Head Injury): self-explanatory

MEDICATIONS (MEDS) (Circle the medication given and write the time given in the notes)

NOTES (Include any additional information (location/country, euthanized/KIA, treatment regiments that were used to the treat the patient etc.)

DISPOSITION OF THE FORM – (The form is to be kept with the patient until it can be put into the patient's record.) Pass the card to the next treatment facility. 1) Scan and email the card to dog.consult@us.af.mil . 2) Put the card into the patient's hard copy record. CAVEAT: For US Special Operations Command (SOCOM) canines, the cTCCC card will be filled out and returned to the handler or operator. The handler or operator will route the card to their respective veterinarian to be inputted into the MWD Trauma Registry and the canine's record.

DEFINITIONS

IED – Improvised explosive device
GSW – Gunshot wound
TQ – Tourniquet
ET – Endotracheal tube
TXA – Tranexamic acid

CANINE-TACTICAL COMBAT CASUALTY CARE CARD (cTCCC)

EVAC CAT: ☐Urgent ☐Priority ☐Routine

EVAC TYPE: ☐Fixed ☐Rotary ☐Ground ☐MEDEVAC ☐CASEVAC

UNIT: _____ **NAME:** _____ **TATTOO:** _____

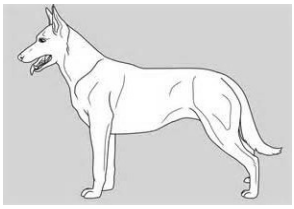
DATE: (DD-MM-YY)_____ **TIME:** _____ **GENDER:** ☐**M** ☐**F**

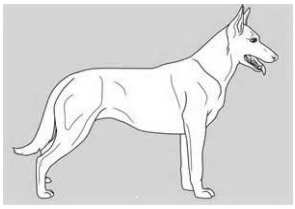
Mechanism of Injury: (Mark **X** all that apply

☐IED ☐GSW ☐MINE ☐BURN ☐GRENADE ☐ARTILLERY ☐FALL

☐OTHER: _____

Injury: (Mark all injuries that apply with an **X**)





Signs and Symptoms: (fill in the blank)

Time					
Pain Score (0-10)					
Temperature (99-102.5)					
Pulse Rate/Location (60-80)					
Respirations (16-30)					
Blood Pressure (120/80)					
Pulse Ox% (> 95%)					
Capillary Refill (< 2 sec)					

NOTES: _____

_____

_____

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CANINE-TACTICAL COMBAT CASUALTY CARE CARD (cTCCC)

Treatments: (Mark **X** all that apply) and fill in the blank) ***Location*:**

M: Dressing - ☐Hemostatic ☐Pressure ☐TQ Other: _____

A: ☐Intact ☐ET-Tube ☐Tracheostomy _____

R: ☐O^2 ☐Needle-D ☐Chest-Tube ☐Chest-Seal _____

C:

Total Crystalloid Shock Volume of fluids is 90 mls/kg:
Administer 20ml/kg over 10-20 min. Reassess (as with human casualty):
If lack of response after 2-3 boluses consider adjunct therapy (HES/HTS.)

CRYSTALLOID	Volume	Route	Time
HYDROXYETHYL STARCH (HES): 5mls/kg over 5 - 10 min. After ½ shock crystalloid not effective.			
HYPERTONIC SALINE (HTS): 4mls/kg (If two or three ¼ shock boluses and 1-2 boluses of HES not effective)			
TXA: 10 mg/kg IV in 100ml NaCl or LRS given in first 3hrs. Followed by a 10-15 mg/kg CRI over 8 hours.			

C: ☐Splint ☐Other Bandage _____

H: ☐Hypothermia-Prevention ☐Hypethermia-External Cooling

H: ☐Head Injury

Pain Meds and Antibiotics (Circle if given and write the time in the notes.)

DRUG (conc)	DOSE	RTE	60lb/ 27.3kg	70lb/32kg	80lb/36.4kg
Ketamine (100mg/ml)	2-5mg/kg	IV/IM	1 ml	1.5 mls	2 mls
Midazolam (5mg/ml)	0.1-0.3mg/kg	IV/IM	3 mls	4 mls	5 mls
Morphine (10mg auto inj.)	0.2-0.5 mg/kg	IM	1 *auto*	1 *auto*	2 *auto*
Meloxicam	0.1-0.2mg/kg	IV/SQ/PO	5 *mg*	6 *mg*	7 *mg*
Cefazolin/Ceftriaxone	25 mg/kg	IV/IM	600 *mg*	800 *mg*	900 *mg*
Cefotaxime	25 mg/kg	IV/IM/SQ	600 *mg*	800 *mg*	900 *mg*
Ertapenem (100mg/ml)	15mg/kg	IV/SQ	4 mls	5 mls	6 mls

NOTES: _____

_____

FIRST RESPONDER:

Name (Last, First): _____ **AOC/MOS:** _____

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LINE	*ITEM*	*EVACUATION REQUEST MESSAGE*
1	Location of Pickup Site.	
2	Radio Frequ., Call Sign, & Suffix.	
3	No. of Patients by Precedence.	
4	Special Equipment Required.	
5	Number of Patients by Type.	
6	Security of Pickup Site (Wartime).	
6	Number and Type of Wound, Injury, or Illness (Peacetime).	
7	Method of Marking Pickup Site.	
8	Patient Nationality and Status.	
9	NBC Contamination (Wartime).	
9	Terrain Description (Peacetime).	

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August 2016 Use of previous version authorized until exhausted

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HEADQUARTERS, DEPARTMENT OF THE ARMY,
ATTN: ATIC-SAA, GTA Program, Fort Eustis, VA 23604-5166

LINE ITEM	EXPLANATION
1. Location of Pickup Site.	Encrypt grid coordinates. When using *DRYAD Numeral Cipher, the same SET line* will be used to encrypt grid zone letters and coordinates. To preclude misunderstanding, a statement is made that grid zone letters are included in the message (unless unit SOP specifies its use at all times).
2. Radio Frequency, Call Sign, Suffix.	Encrypt the frequency of the radio at the pickup site, *not* a relay frequency. The call sign (and suffix if used) of person to be contacted at the pickup site may be transmitted in the clear.
3. No. of Patients by Precedence.	Report only applicable info & encrypt brevity codes. A = Urgent, B = Urgent-Surg, C = Priority, D = Routine, E = Convenience. (If 2 or more categories reported in same request, insert the word "break" btwn. each category.)
4. Spec Equipment.	Encrypt applicable brevity codes. A = None, B = Hoist, C = Extraction equipment, D = Ventilator.
5. No. of Patients by Type.	Report only applicable information and encrypt brevity code. If requesting MEDEVAC for both types, insert the word *"break"* between the litter entry and ambulatory entry: L + # of Pnt -Litter; A + # of Pnt - Ambul (sitting).
6. Security Pickup Site (Wartime).	N = No enemy troops in area, P = Possibly enemy troops in area (approach with caution), E = Enemy troops in area (approach with caution), X = Enemy troops in area (armed escort required).
6. Number and type of Wound, Injury, Illness (Peacetime).	Specific information regarding patient wounds by type (gunshot or shrapnel). Report serious bleeding, along with patient blood type, if known.
7. Method of Marking Pickup Site.	Encrypt the brevity codes. *A* = Panels, *B* = Pyrotechnic signal, *C* = Smoke Signal, *D* = None, *E* = Other.
8. Patient Nationality and Status.	Number of patients in each category need not be transmitted. Encrypt only applicable brevity codes. A = US military, B = US civilian, C = Non-US mil, D = Non-US civilian, E = EPW.
9. NBC Contamination, (Wartime).	Include this line only when applicable. Encrypt the applicable brevity codes. N = nuclear, B = biological, C = chemical.
9. Terrain Description (Peacetime).	Include details of terrain features in and around proposed landing site. If possible, describe the relationship of site to a prominent terrain feature (lake, mountain, tower).

NATO AEROMEDICAL EVACUATION 9 LINE

NATO MEDEVAC " 9-Line" REQUEST				DTG: UNIT:	
1	**LOCATION (GRID OF PICKUP ZONE)**			(1)	
2	**CALL SIGN & FREQ:**			(2)	
3	**NUMBER OF PATIENTS/ PRIORITY**:			(3) P1 ……. P2 ……. P3 …….	
	PRIORITY 1(P1) - URGENT; to be at hospital facility (R2/ R3) within 60 minutes			**PRIORITY 2 (P2)**- To be at hospital facility (R2/ R3) within 4 hours of notification	
	PRIORITY 3 (P3) - To be at hospital facility R2/R3 within 24 hours of notification				
4	**SPECIAL EQUIPMENT REQUIRED:**			(4)	
	A - NONE	B - HOIST (Winch)		C - EXTRICATION	D - VENTILATOR
5	**PATIENTS BY TYPE**			(5) L ….. A ……. E ……..	
	S- STRETCHER (On Litter)	W-WALKING (Ambulatory)		E-ESCORTS/O-Other (Give details)	
6	**SECURITY AT PICKUP ZONE (PZ)**			(6)	
	N - NO ENEMY	E - ENEMY IN AREA			
	P - POSSIBLE ENEMY	X - HOT PICKUP ZONE - ARMED ESCORT REQUIRED			
7	**PICKUP ZONE (PZ) MARKING METHOD**			(7)	
	A - PANELS	B - PYRO	C - SMOKE	D - NONE	E - OTHER (explain)
8	**NUMBER OF PATIENTS BY NATIONALITY/STATUS**			(8) A ……. B ……. C ……. D …… E …….. F …….	
	A - NATO MILITARY B - NATO CIVILIAN			C - NON-NATO SECURITY FORCES	
	D - NON-NATO CIVILIAN E - POW/DETAINEE			F - EMBEDDED INTERPRETER	
	G- CIV CAS (caused by friendly forces)			H-CHILD	
9	**TACTICAL CONSIDERATIONS/OTHER INFORMATION**			(9)	

DO NOT DELAY LAUNCH OF MEDEVAC SUPPLY FURTHER INFORMATION ONCE AVAILABLE:		
M	MECHANISM OF INJURY (and at what time if known)	(M) (Time: ……)
I	INJURY OR ILLNESS SUSTAINED	(I)
S	SYMPTOMS AND VITAL SIGNS **C-Catastrophic bleed** **A-Airway B-Breathing Rate** **C-Pulse D-Consciousness** **E-Other signs**	(C)…… A …… B …… C …… D …… E ……
T	TREATMENT GIVEN & TIME (e.g. Tourniquet and time applied, Morphine)	(T)
A	AGE OF CASUALTY	
T	TIME OF WOUNDING	

NOTES:

Specify if critical medical supplies are needed to be brought in with MEDEVAC
'9-liner" is not used for requests to move casualties who are killed in action at the scene

APRV'S MSN		AVN AUTH'S LAUNCH	
W/U	W/D	W/U	W/D

Drug Box Layout, Drug Box Drug Cards and Drug Box Pocket Labels

1. 3mL Syringe x5
2. 5mL Syringe x4
3. 10mL Syringe x3
4. Saline Lock x6
5. IV Catheter 16GA x3
6. IV Catheter 18GA x3
7. Draw Needles x8
8. Alcohol Pads x10
9. 1 Inch Tape x1
10. 1 Inch Tape x1
11. Tegaderm Kit w/Constricting Band x4

TOP

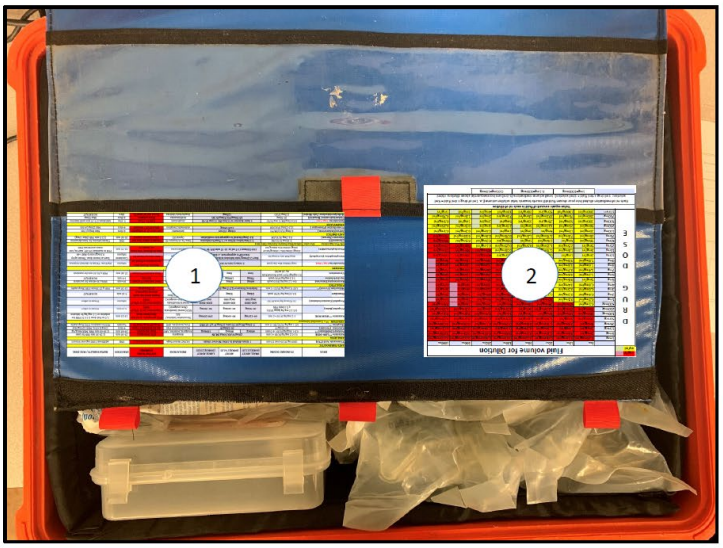
1. TXA x3
2. VASOPRESSIN x2
3. NOREPINEPHRINE x2
4. PHENYLEPHRINE x2
5. EPINEPHRINE x2
6. DOPAMINE x2
7. SOLU-MEDROL x2
8. DIPHENHYDRAMINE x3
9. ONDANSETRAN x3
10. AMIODARONE x3
11. NARCAN x3
    FLUMAZENIL x1

FRONT DIVIDER

Drug Box Layout, Drug Box Drug Cards and Drug Box Pocket Labels

BACK OF DIVIDER

1. Quick Drug Reference Card per SMOG
2. Fluid Volume for Dilution card per SMOG



BOTTOM

1. ACLS Drugs
   - -Epineprhine x4
   - -Adenosine x2
   - -Sodium Bicarb x2
   - -Lidocaine x3
   - -D50 x1
   - -Atropine x2
   - -Calcium Chloride x2
2. SHARPS SHUTTLE x1
   SALINE FLUSHES x10
3. IV TUBING x4
   BLOOD TUBING x2
4. NORMAL SALINE 100mL x3
5. NARCOTICS BOX
   Ketamine x2
   Midazolam x2
   Rocuronium x2
   Vecuronium x2
   Succinylcholine x1
   Fentanyl x3
   Etomidate x1
6. NORMAL SALINE 500mL x2
   LACTATED RINGERS x1
   3% HYPERTONIC SALINE x1

3mL SYRINGE x5	5mL SYRINGE x4	10mL SYRINGE x3	SALINE LOCK x6
IV CATHETER 16GA x3	IV CATHETER 18GAx3	DRAW NEEDLES X8	ALCOHOL PAD x10
1 inch TAPE	1 inch TAPE	TEGADERM x4	

TOP

Fluid volume for Dilution

mcg/ml
mg/ml

DRUG DOSE

	5cc	10cc	20cc	50cc	100cc	250cc	500cc	1000cc
1mcg	0.20mcg/ml	0.1mcg/ml	0.05mcg/ml	0.02mcg/ml	0.01mcg/ml	0.004mcg/ml	0.002mcg/ml	0.001mcg/ml
5mcg	1mcg/ml	0.5mcg/ml	0.25mcg/ml	0.1mcg/ml	0.05mcg/ml	0.02mcg/ml	0.01mcg/ml	0.005mcg/ml
10mcg	2mcg/ml	1mcg/ml	0.5mcg/ml	0.2mcg/ml	0.1mcg/ml	0.04mcg/ml	0.02mcg/ml	0.01mcg/ml
25mcg	5mcg/ml	2.5mcg/ml	1.25mcg/ml	0.5mcg/ml	0.25mcg/ml	0.1mcg/ml	0.05mcg/ml	0.025mcg/ml
50mcg	10mcg/ml	5mcg/ml	2.5mcg/ml	1mcg/ml	0.5mcg/ml	0.2mcg/ml	0.1mcg/ml	0.05mcg/ml
100mcg	20mcg/ml	10mcg/ml	5mcg/ml	2mcg/ml	1mcg/ml	0.4mcg/ml	0.2mcg/ml	0.1mcg/ml
250mcg	50mcg/ml	25mcg/ml	12.5mcg/ml	5mcg/ml	2.5mcg/ml	1mcg/ml	0.5mcg/ml	0.25mcg/ml
500mcg	0.1mg/ml	50mcg/ml	25mcg/ml	10mcg/ml	5mcg/ml	2mcg/min	1mcg/m	0.5mcg/ml
1mg	0.2mg/ml	0.1mg/ml	50mcg/ml	20mcg/ml	10mcg/ml	4mcg/ml	2mcg/m	1mcg/ml
2mg	0.4mg/ml	0.2mg/ml	0.1mg/ml	40mcg/ml	20mcg/ml	8mcg/ml	4mcg/m	2mcg/ml
3mg	0.6mg/ml	0.3mg/ml	0.15mg/ml	60mcg/ml	30mcg/ml	12mcg/ml	6mcg/m	3mcg/ml
4mg	0.8mg/ml	0.4mg/ml	0.2mg/ml	80mcg/ml	40mcg/ml	16mcg/ml	8mcg/m	4mcg/ml
5mg	1mg/ml	0.5mg/ml	0.25mg/ml	0.1mg/ml	50mcg/ml	20mcg/ml	10mcg/ml	5mcg/ml
6mg	1.2mg/ml	0.6mg/ml	0.3mg/ml	0.12mg/ml	60mcg/ml	24mcg/ml	12mcg/ml	6mcg/ml
7mg	1.4mg/ml	0.7mg/ml	0.35mg/ml	0.14mg/ml	70mcg/ml	28mcg/ml	14mcg/ml	7mcg/ml
8mg	1.6mg/ml	0.8mg/ml	0.4mg/ml	0.16mg/ml	80mcg/ml	32mcg/ml	16mcg/ml	8mcg/ml
9mg	1.8mg/ml	0.9mg/ml	0.45mg/ml	0.18mg/ml	90mcg/ml	36mcg/ml	18mcg/ml	9mcg/ml
10mg	2mg/ml	1mg/ml	0.5mg/ml	0.2mg/ml	0.1mg/ml	40mcg/ml	20mcg/ml	10mcg/ml
15mg	3mg/ml	1.5mg/ml	0.75mg/ml	0.3mg/ml	0.15mg/ml	60mcg/ml	30mcg/ml	15mcg/ml
25mg	5mg/ml	2.5mg/ml	1.25mg/ml	0.5mg/ml	0.25mg/ml	0.1mg/ml	50mcg/ml	25mcg/ml
50mg	10mg/ml	5mg/ml	2.5mg/ml	1mg/ml	0.5mg/ml	0.2mg/ml	0.1mg/ml	50mcg/ml
75mg	15mg/ml	7.5mg/ml	3.75mg/ml	1.5mg/ml	0.75mg/ml	0.3mg/ml	0.15mg/ml	75mcg/ml
100mg	20mg/ml	10mg/ml	5mg/ml	2mg/ml	1mg/ml	0.4mg/ml	0.2mg/ml	0.1mg/ml
250mg	50mg/ml	25mg/ml	12.5mg/ml	5mg/ml	2.5mg/ml	1mg/ml	0.5mg/ml	0.25mg/ml
500mg	100mg/ml	50mg/ml	25mg/ml	10mg/ml	5mg/ml	2mg/ml	1mg/ml	0.5mg/ml
750mg	150mg/ml	75mg/ml	37.5mg/ml	15mg/ml	7.5mg/ml	3mg/ml	1.5mg/ml	0.75mg/ml
1Gram	200mg/ml	100mg/ml	50mg/ml	20mg/ml	10mg/ml	4mg/ml	2mg/ml	1mg/ml

Value equals amount of fluid in each ml of dilution

Each ml of medication diluted into your chosen fluid still counts towards total solution volume (i.e. 1ml of drug + 4ml fluid = 5ml solution; 1ml drug + 9ml fluid = 10ml solution). Small volume medications (1-2ml) are inconsequential above dilutions >50ml

1mg=1000mcg | 0.1mg=100mcg | 0.01mg=10mcg

DRUG	STANDARD DOSING	SMALL ADULT (60KG)132LBS	ADULT (80KG)176LBS	LARGE ADULT (100KG)220LBS	INDICATIONS	RESTRICTIONS/ WARNINGS	DURATION	REPEATABILITY/ MAX DOSE
ANTI-FIBRINOLYTIC								
Tranexamic Acid (TXA)	1000 mg IV/IO over 10 min	1 Gram diluted in 100cc NS over 10min			Int/Ext Hemorrhage	Give <3 hrs from injury	UNK	additional 1000 mg over 8 hours
ANALGESIA								
Ketamine ** LOW-DOSE	0.1-0.2 mg/kg IV/IO >1 min	20mg IV/IO; 50mg IM/IN			Analgesia	HTN, Emergence	20-30 min	Q 20-30 min PRN for pain
Fentanyl (Sublimaze) **	0.5-1 mcg/kg IV/IO >3-5 min	60mcg	80mcg	100mcg	Analgesia, Sedation, AMI	Resp depression	30-60 min	Q 30-60 min PRN, MAX 4mcg/kg
Ketorolac (Toradol)	10-15mg IV	10-15mg IV			Musculoskeletal Pain	Not for Battlefield Trauma	4-6hrs	15mg Q 6 hrs, MAX 120mg/day
Morphine **	0.5-1 mg/kg IV/IO/IM >3 min	5-10mg IM q 20-30 min; 2-5mg IV q 5-15 PRN			Pain, Anxiolytic, AMI	Resp/BP drop, Head Tx	Variable	PRN for sedation if BP/Resp stable
SEDATION ** = Controlled Substance								
Ketamine ** HIGH DOSE	1-2 mg/kg IV/IO >2 min	60-120mg	80-160mg	100-200mg	Dissociative Sedation/ RSI	HTN, emergence, avoid sub-dissociative doses	10-20 min	1/2 to Full dose Q 10-20 PRN for sedation or 1-3 mg/kg/hr infusion
Propofol (Bolus)	0.5-1.5 mg/kg bolus IV/IO, q 5-10min PRN	30-90mg	40-120mg	50-150mg	RSI/General Anesthesia (Non-analgesic)	Hypotension (up to 30% of MAP)	3-10 min	Titrate to effect
Propofol (Constant Infusion)	10-50 mcg/kg/min IV/IO	600-3000 mcg/min	800-4000 mcg/min	1000-5000 mcg/min	General Anesthesia Maint. (Non-analgesic)	Hypotension (up to 30% of MAP)	Infusion	Titrate to effect
Etomidate	0.3-0.5mg/kg IV/IO push	24mg	32mg	40mg	Sedation, RSI (Non-analgesic)	Repeat doses can cause adrenal suppresion	5-10 min	NO REPEAT
Midazolam (Versed)**	0.05-0.1mg/kg IV/IO >1 min	Sedation/Seizures=2.5-5 mg; Status Epilep=10mg			Sedation, Seizures	BP/Resp drop	10-30 min	PRN q 15-30min if BP/Resp stable
PARALYTICS								
Rocuronium (Zemuron)	0.6-1.2 mg/kg IV/IO push	60mg	80mg	100mg	RSI/ Maint of paralysis	Must maintain PT airway	30+min	PRN q 30-45min for paralysis
Succinylcholine	1-1.5 mg/kg IV/IO push	75mg	100mg	125mg	RSI	RSI Only	5-9 min	NO REPEAT
Vecuronium	0.1 mg/kg IV/IO push Reconstitute w/ 10 ml NS	6mg	8mg	10mg	Maint of paralysis	Must maintain PT airway	25-40 min	PRN q 30-60 min for paralysis
PRESSERS								
Epinephrine 1mg/10mL	1mg/500ml NS= 2mcg/ml	2-10mcg/min IV/IO infusion			Hypotension	Must be diluted/ Max resuscitation w/blood 1st	Infusion	Start low; Titrate to desired response
Norepinephrine (Levophed)	4mg/500 ml= 8 mcg/ml	Start 2-20mcg/min infusion initally. (adjust for BP) Once BP is appropriate, 2-4mcg/min			Hypotension	Max resus w/ blood 1st	Consistent Infusion	Start at lowest dose. Titrate up by 0.5mcg/min to MAP >60
Phenylephrine(NEO)	10mg/100ml NS= 100mcg/ml or 10mg/250ml NS= 40mcg/ml	100-500mcg (1-5 ml) q 10-15 min IVP/IO >1min			Hypotension	Must be diluted/ Max resus w/ blood 1st	10-15 min	PRN to maintain SYS BP; start w/ low doses and titrate PRN
OD/Tox Ingestions (See also Sodium Bicarbonate, Calcium Chloride)								
Glucagon Kit	3-10mg IV/IO/IM	3-10mg bolus; follow w/ 3-5mg/hr infusion			Beta/Ca-ch blocker OD	Dosage is higher than site	UNK	Titrate infusion for hemodynamics
Naloxone (Narcan)	0.4-2mg IV/IO/IM	0.4-2mg titrated to appropriate ventilation			Opioid OD	Use minimum needed	20-60 min	Q 2-3 min PRN (Max 10mg)
ANTI-EMETICS								
Zofran(Ondansetron)	4-8mg IV/IO/IM/PO	4-8mg >30 sec			Antiemetic	Can cause QT prolongation	4-6hrs	Max 8mg q 6 hrs
Promethazine (Phenergan)	12.5-25mg IV/IO/IM	12.5-25mg			Antiemetic/Sedation	Altered LOC/ Vesicant	4-6hrs	Max 25mg q 4 hrs
ANAPHYLAXIS								
Epinephrine 1mg/1mL	0.3-0.5mg IM; 0.1mg IV/IO	1 Auto-Injector or 0.3mg IM; 0.1mg IV/IO			Anaphylaxis	Hold for 10 sec	5-15m	Add doses Q 5-15 min until improve
Diphenhydramine (Benadryl)	25-50mg	25-50mg PO; 50mg IV/IO			Antihistamine	Minor sedation	4-8hrs	Max 50mg
Methylprednisolone/Solu-Medrol	125mg IV/IO	125mg			Anaphylaxis/Asthma	Do not use for head Tx	4hrs	NO REPEAT

DIVIDER

BACK OF

TXA x3	VASOPRESSIN x2	NOREPINEPHRINE x2	PHENYLEPHRINE x2
EPINEPRHINE x2	DOPAMINE x2	SOLU-MEDROL x2	DIPHENHYDRAMINE x3
ONDANSETRAN X3	AMIODARONE x3	NARCAN x3 FLUMAZENIL x2	

FRONT
DIVIDER

ACLS DRUG:

EPINEPHRINE x4
ADENOSINE x2
SODIUM BICARB x2
LIDOCAINE x3
D50 x2
ATROPINE x2
CALCIUM CHLORIDE x2

SALINE FLUSHES x10

BOTTOM

IV TUBINGx4
BLOOD TUBINGx2

NORMAL SALINE 100ML x3
NORMAL SALINE 500ML x2
LACTATED RINGERS x1
3% HYPERTONIC SALINE x2

NARCOTICS BOX:

KETAMINE x2
ROCURONIUM x2
VECURONIUM x2
FENTANYL x3
MIDAZOLAM x2
ETOMIDATE x1
SUCCINYLCHOLINE x1

STANDING ORDERS - Air Ambulance, Emergency Medicine Tasks

PURPOSE

The intended purpose of these guidelines is to serve as a baseline for the Aviation Medical Company's Aviation Medicine SOP (Standing Orders and Aeromedical Treatment Guidelines). Practices in Aviation Medicine undergo constant scrutiny and change. As such, this guide should not be considered an all-inclusive and always up-to-date source of the newest and most relevant policies, procedures, and practices in Aviation Medicine. It will require continued monitoring for relevant clinical and operational updates needed to reflect current aviation and clinical practice standards.

Primarily, this guide should serve as a resource for tactical and non-tactical prehospital, interfacility and post-surgical enroute medical care on an Army aeromedical platform. Initial patient evacuation and prehospital trauma guidelines are written in a manner to support the principles of Tactical Combat Casualty Care (TCCC). This assumes that a combat trauma patient will respond to care most effectively when the order of care addresses circulation (stopping and preventing hemorrhage) prior to addressing the patient's airway and breathing. When these guidelines are adapted for use within US Army civilian missions (noncombat), unit medical directors should consider the necessity of writing and appending these guidelines, order of care, and standard operating procedures to address the differences in initial interventions of the civilian trauma patient verses the combat trauma patient.

SCOPE OF PRACTICE

This guide is intended for use by Aviation Medical Personnel to include: Critical Care Flight Paramedics, Flight Surgeons, Aeromedical Physician Assistants (APAs), Aeromedical Nurse Practitioners (ANPs), and En Route Critical Care Nurses performing MEDEVAC on an Army Aviation platform. Preferably, only medical personnel trained in and holding certifications in the National Registry of Paramedics (NRP), Emergency Medicine, or Critical Care should be eligible to use all treatment guidelines within this book. However, local training programs may be adopted that may enable individually trained physicians, Physician Assistants, and Non-NRP Flight Medics a knowledge base sufficient to satisfy use of these treatment guidelines in an austere/combat environment. Specific certifications of importance might include: TCMC, ATLS®, ACLS/ALS, PALS, PHTLS, ITLS, and PEPP, among others. Any individual who is not fully trained, has not demonstrated competency in each of these guidelines, or has not been approved (credentialed) to use these guidelines by the local Aviation Medicine Medical Director should not be authorized to perform the respective guideline(s) without direct (on-hand) oversight. All personnel using these guidelines should adhere to the steps and standards as outlined in each of the standard medical operating guidelines (SMOG) and procedures. Moreover, all unit medical personnel providing care aboard US Army Air Ambulances (including Unit Flight Surgeons and APAs) will, at a minimum, adhere to this standard of care unless superseded by theater and/or regional clinical practice guidelines under the authorization of an appropriate local command medical officer/surgeon.

Following the concept set forth in the National Emergency Medical Services (EMS) Scope of Practice Model, an individual may only perform a skill or role for which that person is:

• educated (has been trained to do the skill or role), AND
• certified (has demonstrated competence in the skill or role), AND
• licensed [has legal authority issued by the State (Army EMS is the 51st State) to perform the skill or role], AND
• credentialed (has been authorized by medical director to perform the skill or role).

Depending on the military environment (deployed or austere location), licensing and credentialing may be satisfied through a local training and standardization policy that demonstrates an individual medical provider's capabilities and knowledge of the treatment guidelines within this handbook. Approval of each individual provider's usage of these treatment guidelines must be provided by the unit medical director. This approval should be documented and maintained in the Soldiers training record.

It must be remembered that any use of these guidelines is prohibited outside of the individual's military employment. Furthermore, any civilian based medical care provided by aviation medicine personnel must satisfy the National EMS Scope of Practice Model noted previously. It must also be realized that any usage of these guidelines within the civilian environment may be limited to support through a legitimate local EMS credentialing provider. This would normally be the local Medical Treatment Facility Emergency Medical Systems credentialing authority. The unit medical director may or may not satisfy this requirement in civilian medicine due to state laws, policies, or standards.

USAGE INTENT

This guide contains the specific Treatment Guidelines, Procedures, and Medications that will be used within Army Aeromedical Evacuation.

The Critical Care Flight Paramedic Standard Medical Operating Guideline will be reviewed at a minimum semi-annually or upon change of command or medical director. A single copy of the Review and Approval Page or a substitute document will be distributed to aforementioned individuals for review and approval signatures.

It is the responsibility of the Unit Commander, the Medical Director, the Training NCO, and the Standards NCO to ensure that all Flight Paramedics remain current in all required certifications needed to perform their duties as Flight Paramedics and/or those needed to perform the skills of a Nationally Registered Paramedic. This should include, at a minimum, certifications in NRP, ALS/ACLS, and BLS. However, it is highly recommended that paramedics maintain certifications in PALS/PEPP and PHTLS/ITLS. Copies or originals of all current certifications or a memo of training status/credentials will be maintained in the individual Soldier's training record.
A medical practitioner's clinical competence is at least equal in importance to the maintenance of formal certifications. Competence is the ability to actually perform required interventions and administer appropriate therapies. A competent practitioner has the knowledge base and critical-thinking skill required to determine when to perform an intervention and when it is best NOT to do so. Commanders and Unit Medical Directors/ Flight Surgeons should ensure that clinical skill competency is maintained, demonstrated, and remediated (when required) to ensure the maintenance of skills and mandated certifications of medical aircrew members under their direction. It is recommended that all medical personnel conducting aeromedical evacuation

perform simulated critical care and POI training cases on a monthly basis in order to develop competency and retain critical care medical proficiency.

The Flight Paramedic Standard Medical Operating Guideline is not intended to be a comprehensive patient care manual. Rather, it specifies standard clinical treatment guidelines for discrete emergency conditions which should be used as a baseline practice standard for Flight Paramedics and other attached medical aircrew members providing enroute emergency care on a rotary wing platform in the prehospital environment while conducting intratheater, CONUS, or other tactical/operational contingency missions.

QUALITY MANAGEMENT PROGRAM Procedures

Physician Medical Direction

Prehospital emergency care constitutes the practice of medicine, either directly by a qualified physician or indirectly through delegation-of-authority under the physician's medical direction. This practice is distinctly different from hospital-based medical, nursing, and paramedical practice in which practitioners conduct full-spectrum care within their respective scope-of practice, executing physician's orders, or through autonomous practice in the case of Physician Assistants (PA), Nurse Practitioners (NP), and Clinical Nurse Specialists (CNS).

Medical direction of Flight Paramedics and other medical aircrew with regard to procedures, guidelines, medications, documentation (Patient Care Reports), testing, credentials, etc., is the primary responsibility of the qualified (as defined by AR 40-3) assigned Flight Surgeon (FS) (normally a Battalion Surgeon), with the assistance of the Aeromedical Physician Assistant (APA) and designated company Medical Training NCO. The Brigade Surgeon has responsibility for overall medical oversight. All medical aircrew should maintain currency on recent literature and equipment pertaining to pre-hospital aeromedical evacuation and enroute care.

Advanced-Care Provider Clinical Oversight

Although they cannot act as a medical director, the role of PAs, NPs and CNSs in the practice of prehospital emergency care is emerging and holds great promise as a means of extending the medical director's capacity to ensure the best quality of care for patients or casualties. While Federal Regulations and most State Laws pertaining to EMS require physician medical direction for the prehospital conduct of advanced life support (ALS) scope-of-practice skills, many high performance domestic EMS systems have implemented mid-level "clinical director" programs, employing PAs and advanced practice nurses with emergency or critical care expertise, to provide initial quality management program (QMP) review, assist with on-line decision support for pre-hospital practitioners, oversee readiness training and continuing education, and to augment the medical aircrew when needed on ground and air critical care transport platforms. PAs, with the approval of the Brigade Surgeon, can provide the necessary clinical oversight in the absence of a unit level Flight Surgeon in order to ensure the CCFPs are trained and proficient for their deployed mission.

Quality Assurance

Published Standard Medical Operating Guidelines (SMOG) are written patient care guidance in algorithm format with discrete basic life support (BLS) and advanced life support (ALS) scopes of practice, respectively, based on each patient / casualty's specific medical condition. Once endorsed by local commanders and unit medical directors, all medical aircrew are expected to use these guidelines in the care of patients they transport to the next higher level of care. Periodically, medical aircrew should undergo testing on information and procedures contained within these guidelines. After each patient that has been aero-medically evacuated to a Role 2 or Role 3 medical treatment facility, each medical aircrew member is responsible for documenting the care rendered during transport via the appropriate unit, theater, or DA / DD approved / mandated electronic or written patient care documentation form

Direct Supervision

In addition to the written guidelines, designated unit medical directors are responsible for the direct supervision of medical aircrew members participating in en route care within the unit, his/her performance in situations in which the patient's medical condition(s) does not meet standard-of-care as defined by these guidelines, or who experience adverse events en route, merit retrospective review and determination of root cause and corrective action, or endorsement of their decision, as appropriate.

Quality Management/Process Improvement

After each Aeromedical Evacuation mission, for each patient receiving enroute care, the medical aircrew team conducts an informal After Action Review (AAR). The initial formal control measure is the requirement for the FS or APA to review and co-sign each patient care report (PCR) (e.g., DD 1380, run sheet, Enroute Critical Care Transfer document, DD4700) before it is submitted as a part of the patient record. After both the lead medical aircrew member and unit medical director have signed the PCR, a copy will be kept and others will be distributed in accordance with current Army policy guidelines, local unit policy, and by the medical training NCO and/or medical director.

Additional quality control measures are encouraged and can foster a rich and open learning environment between local emergency medicine/trauma facilities and members of the air ambulance company. One such option might include a monthly aeromedical evacuation conference chaired by the local MTF Trauma Surgeon in which medical aircrew member's present cases to a forum of providers and other medics with emphasis on best practices and lessons learned.

UPDATE and APPROVAL PROCESS

1. The Critical Care Flight Paramedic Standard Medical Operating Guidelines will be updated generally on an annual basis, or sooner in response to clinical or operational needs.

2. Based upon the above timeframes, the Director, Department of Aviation Medicine (DAM) should initiate an update by sending the SMOG for inputs from senior aeromedical clinicians (flight surgeons, aeromedical physician assistants, and aeromedical nurse practitioners), emergency medicine physicians, EMS trained physicians, and critical care flight paramedic end-users.

3. Suspense for submitting updates back to an identified editor will be a minimum of 30 calendar days. Extensions may be granted on a case by case basis.

4. The editor will consolidate all inputs and discuss with a designated physician (as identified by the Director, DAM).

5. After all accepted/applicable inputs have been updated; the SMOG will receive final approval from Director, DAM.

6. Once final approval is given, the SMOG will undergo OPSEC/PAO review prior to posting.

POINT OF INJURY CARE, TCCC Evacuation Phase Guideline

INDICATIONS: In combat, the period of care provided at the Point of Injury (POI) is the most critical period throughout a casualty's movement across the medical system. Timely, appropriate, and effective care at the POI will afford a casualty the greatest chance of surviving preventable causes of death regardless of necessary follow-on surgical interventions and specialty medical treatment.

GUIDELINE (see TACTICAL EVACUATION Guideline). This guideline serves as the starting point for initiation of care for all patients evacuated from the POI pick-up sight. All subsequent procedural steps of care will be determined by navigation through continued guideline flow charts. All care will be provided in accordance with these flow charts.

POLICY NOTE: In the event these guidelines are adapted for use within US Army civilian missions (non-combat), it is recommended that unit medical directors consider the necessity of writing and appending these guidelines, order of care, and standard operating procedures to address the differences in initial interventions of the civilian trauma patient verses the combat trauma patient.

MEDICAL DIRECTOR / UNIT COMMANDER

REVIEW AND APPROVAL PAGE

It is the responsibility of the Unit Commander, the Medical Director, the Training NCO, and the Standards NCO to ensure that all Flight Paramedics remain current in all required certifications needed to perform their duties as Flight Paramedics and/or those needed to perform the skills of a Nationally Registered Paramedic. This includes, at a minimum, certifications in NRP, ACLS/ALS, and BLS. Copies or originals of all current certifications will be placed maintained in the individual Soldiers training record. It is recommended that all CCFP level providers maintain PALS certifications and Flight Paramedic- Certified (FP-C) certifications.

The Standard Medical Operating Guideline is not intended to be a comprehensive patient care manual. Rather, it specifies standard medical treatment guidelines to be used by all Flight Paramedics and Medical Providers performing medical care while serving in this unit in an austere, deployed, or garrison environment.

This document has been reviewed by the below noted individuals for correctness, and mission applicability.

Unit Standards Officer/NCO Signature_____ Date_____

Approval/Review Date_____ Initials_____

Unit Training NCO Signature_____ Date_____

Approval/Review Date_____ Initials_____

The Standard Medical Operating Guideline has been reviewed and approved for use by the undersigned.

Medical Director or designated physician

Signature of Approval_____ Date_____

Approval/Review Date_____ Initials_____

Approval/Review Date_____ Initials_____

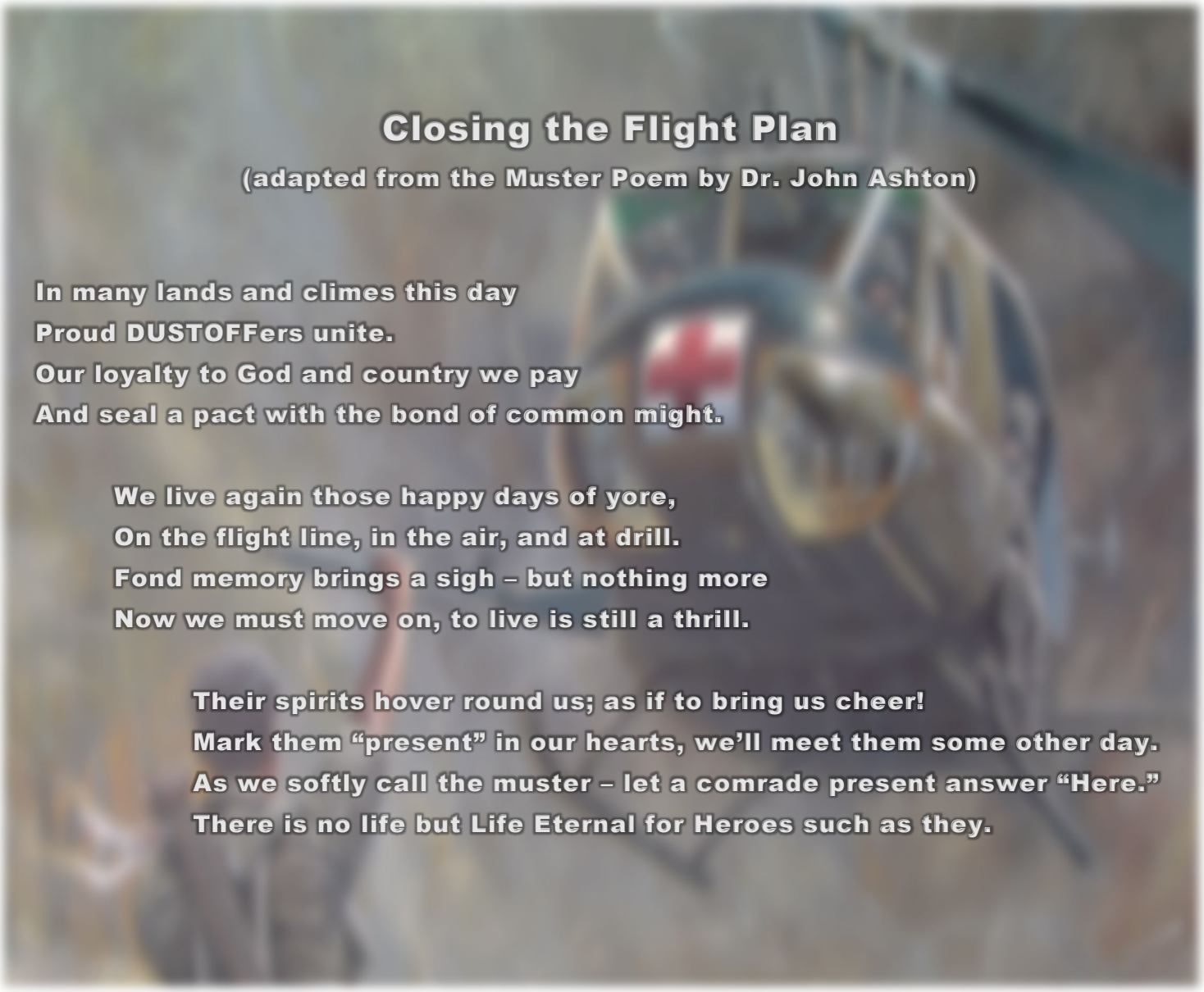
Unit Commander Signature of Approval_____ Date_____

Approval/Review Date_____ Initials_____

Approval/Review Date_____ Medical Director's Initials_____

Additional Medical Director comments and addendums can be attached and should contain counter signature of unit commander for validity.

The Critical Care Flight Paramedic Standard Operating Guidelines are dedicated to our past, present and future DUSTOFF aircrews who un-hesitantly go into harm's way so that other may live. May you forever be protected by angel's wings within the heaven's on which men fly.


Closing the Flight Plan
(adapted from the Muster Poem by Dr. John Ashton)
In many lands and climes this day
Proud DUSTOFFers unite.
Our loyalty to God and country we pay
And seal a pact with the bond of common might.
We live again those happy days of yore,
On the flight line, in the air, and at drill.
Fond memory brings a sigh – but nothing more
Now we must move on, to live is still a thrill.
Their spirits hover round us; as if to bring us cheer!
Mark them "present" in our hearts, we'll meet them some other day.
As we softly call the muster – let a comrade present answer "Here."
There is no life but Life Eternal for Heroes such as they.

Summary of Changes

Page numbers added to all pages. ***NOTE***: Clicking on page numbers sends the reader to the Table of Contents. Items listed on the Table of Contents link directly to the page described. All other previous hyperlinks are disabled.

Protocols Updated

- *Introduction and Table of contents*
- Head Injury/TBI
- Sepsis
- Stroke
- All Cardiac (adult and Ped) Protocols. Now reflect American Red Cross standards
- All Pediatric Protocols. Now reflect American Red Cross PALS standards
- Hypertension
- All MWD Protocols.
- Airway Pearls
- Rapid Sequence Intubation
- Ventilator Management
- Enroute Damage Control Resuscitation
- Pain Management
- Standing Orders
- CDR/Medical Director Approval

Drug Cards Updated

- SMOG Drug Card/Chart
- Atropine
- Calcium Chloride
- Epi 1:10,000 Drip Chart
- Ketamine
- Labetalol
- Midazolam
- Propofol
- Rocuronium
- Tranexamic Acid (TXA)
- Vecuronium

NOTE:

There are many changes throughout the SMOG. Individuals should not just rely on the summary of changes page alone to be up to date on all contents within the SMOG. It is strongly encouraged that individuals go through all the SMOG in its entirety.

Tactical Combat Casualty Care (TCCC) Guidelines for Medical Personnel

15 December 2021

RED text indicates new text in this year's update to the TCCC Guidelines; **BLUE text** indicates text that did not change but was relocated within the guidelines. Recent changes include junctional and airway device recommendations, analgesia, and abdominal evisceration guidelines.

Basic Management Plan for Care Under Fire/Threat

1. Return fire and take cover.

2. Direct or expect casualty to remain engaged as a combatant if appropriate.

3. Direct casualty to move to cover and apply self-aid if able or when tactically feasible, move or drag casualty to cover.

4. Try to keep the casualty from sustaining additional wounds.

5. Casualties should be extracted from burning vehicles or buildings and moved to places of relative safety. Do what is necessary to stop the burning process.

6. Stop life-threatening external hemorrhage if tactically feasible:
    a. Direct casualty to control hemorrhage by self-aid if able.
    b. Use a CoTCCC-recommended limb tourniquet for hemorrhage that is anatomically amenable to tourniquet use.
    c. Apply the limb tourniquet over the uniform clearly proximal to the bleeding site(s). If the site of the life-threatening bleeding is not readily apparent, place the tourniquet "high and tight" (as proximal as possible) on the injured limb and move the casualty to cover.

7. Airway management is generally best deferred until the Tactical Field Care phase.

Basic Management Plan for Tactical Field Care

1. **Establish a security perimeter in accordance with unit tactical standard operating procedures and/or battle drills. Maintain tactical situational awareness.**

2. **Triage casualties as required. Casualties with an altered mental status should have weapons and communications equipment taken away immediately.**

3. **Massive Hemorrhage**

    a. Assess for unrecognized hemorrhage and control all sources of bleeding. If not already done, use a CoTCCC-recommended limb tourniquet to control life-threatening external hemorrhage that is anatomically amenable to tourniquet use or for any traumatic amputation. Apply directly to the skin 2-3 inches above the bleeding site. If bleeding is not controlled with the first tourniquet, apply a second tourniquet side-by-side with the first.
    b. For compressible (external) hemorrhage not amenable to limb tourniquet use or as an adjunct to tourniquet removal, use Combat Gauze as the CoTCCC hemostatic dressing of choice.
        - Alternative hemostatic adjuncts:
            - Celox Gauze or
            - ChitoGauze or
            - XStat (best for deep, narrow-tract junctional wounds)
            - iTClamp (may be used alone or in conjunction with hemostatic dressing or XStat)
        - Hemostatic dressings should be applied with at least 3 minutes of direct pressure (optional for XStat). Each dressing works differently, so if one fails to control bleeding, it may be removed and a fresh dressing of the same type or a different type applied. (Note: XStat is not to be removed in the field, but additional XStat, other hemostatic adjuncts, or trauma dressings may be applied over it.)
        - If the bleeding site is amenable to use of a junctional tourniquet, immediately apply a junctional tourniquet. Do not delay in the application of the junctional tourniquet once it is ready for use. Apply hemostatic dressings with direct pressure if a junctional tourniquet is not available or while the junctional tourniquet is being readied for use.
    c. For external hemorrhage of the head and neck where the wound edges can be easily re-approximated, the iTClamp may be used as a primary option for hemorrhage control. Wounds should be packed with a hemostatic dressing or XStat, if appropriate, prior to iTClamp application.
        - The iTClamp does not require additional direct pressure, either when used alone or in combination with other hemostatic adjuncts.
        - If the iTClamp is applied to the neck, perform frequent airway monitoring and evaluate for an expanding hematoma that may compromise the airway.

Consider placing a definitive airway if there is evidence of an expanding hematoma
- DO NOT APPLY on or near the eye or eyelid (within 1cm of the orbit).

d. Perform initial assessment for hemorrhagic shock (altered mental status in the absence of brain injury and/or weak or absent radial pulse) and consider immediate initiation of shock resuscitation efforts.

4. Airway Management

a. Conscious casualty with no airway problem identified:
   - No airway intervention required
b. Unconscious casualty without airway obstruction:
   - Place casualty in the recovery position
   - Chin lift or jaw thrust maneuver or
   - Nasopharyngeal airway or
   - Extraglottic airway
c. Casualty with airway obstruction or impending airway obstruction:
   - Allow a conscious casualty to assume any position that best protects the airway, to include sitting up and/or leaning forward.
   - Use a chin lift or jaw thrust maneuver
   - Use suction if available and appropriate
   - Nasopharyngeal airway or
   - Extraglottic airway (if the casualty is unconscious)
   - Place an unconscious casualty in the recovery position
d. If the previous measures are unsuccessful, perform a surgical cricothyroidotomy using one of the following:
   - Bougie-aided open surgical technique using a flanged and cuffed airway cannula of less than 10 mm outer diameter, 6-7 mm internal diameter, and 5-8 cm of intratracheal length.
   - Standard open surgical technique using a flanged and cuffed airway cannula of less than 10mm outer diameter, 6-7 mm internal diameter, and 5-8 cm of intra-tracheal length.
   - Use lidocaine if the casualty is conscious.
e. Cervical spine stabilization is not necessary for casualties who have sustained only penetrating trauma.
f. Monitor the hemoglobin oxygen saturation in casualties to help assess airway patency.
g. Always remember that the casualty's airway status may change over time and requires frequent reassessment.

Airway Notes:
- If an extraglottic airway with an air-filled cuff is used, the cuff pressure must be monitored to avoid overpressurization, especially during TACEVAC on an aircraft with the accompanying pressure changes.

- Extraglottic airways will not be tolerated by a casualty who is not deeply unconscious. If an unconscious casualty without direct airway trauma needs an airway intervention, but does not tolerate an extraglottic airway, consider the use of a nasopharyngeal airway.
- For casualties with trauma to the face and mouth, or facial burns with suspected inhalation injury, nasopharyngeal airways and extraglottic airways may not suffice and a surgical cricothyroidotomy may be required.
- Surgical cricothyroidotomies should not be performed on unconscious casualties who have no direct airway trauma unless use of a nasopharyngeal airway and/or an extraglottic airway have been unsuccessful in opening the airway.

5. Respiration/Breathing

a. Assess for tension pneumothorax and treat, as necessary.
   - Suspect a tension pneumothorax and treat when a casualty has significant torso trauma or primary blast injury and one or more of the following:
     - Severe or progressive respiratory distress
     - Severe or progressive tachypnea
     - Absent or markedly decreased breath sounds on one side of the chest
     - Hemoglobin oxygen saturation < 90% on pulse oximetry
     - Shock
     - Traumatic cardiac arrest without obviously fatal wounds

     ❖ If not treated promptly, tension pneumothorax may progress from respiratory distress to shock and traumatic cardiac arrest.

   - Initial treatment of suspected tension pneumothorax:
     - If the casualty has a chest seal in place, burp or remove the chest seal.
     - Establish pulse oximetry monitoring.
     - Place the casualty in the supine or recovery position unless he or she is conscious and needs to sit up to help keep the airway clear as a result of maxillofacial trauma.
     - Decompress the chest on the side of the injury with a 14-gauge or a 10-gauge, 3.25-inch needle/catheter unit.
       - Either the 5th intercostal space (ICS) in the anterior axillary line (AAL) or the 2nd ICS in the mid-clavicular line (MCL) may be used for needle decompression (NDC.) If the anterior (MCL) site is used, do not insert the needle medial to the nipple line.
       - The needle/catheter unit should be inserted at an angle perpendicular to the chest wall and just over the top of the lower rib at the insertion site. Insert the needle/catheter unit all the way to the hub and hold it in place for 5-10 seconds to allow decompression to occur.
       - After the NDC has been performed, remove the needle and leave the catheter in place.

- If a casualty has significant torso trauma or primary blast injury and is in traumatic cardiac arrest (no pulse, no respirations, no response to painful stimuli, no other signs of life), decompress both sides of the chest before discontinuing treatment.

- The NDC should be considered successful if:
  - Respiratory distress improves, or
  - There is an obvious hissing sound as air escapes from the chest when NDC is performed (this may be difficult to appreciate in high-noise environments), or
  - Hemoglobin oxygen saturation increases to 90% or greater (note that this may take several minutes and may not happen at altitude), or
  - A casualty with no vital signs has return of consciousness and/or radial pulse.
- If the initial NDC fails to improve the casualty's signs/symptoms from the suspected tension pneumothorax:
  - Perform a second NDC on the same side of the chest at whichever of the two recommended sites was not previously used. Use a new needle/catheter unit for the second attempt.
  - Consider, based on the mechanism of injury and physical findings whether decompression of the opposite side of the chest may be needed.
  - Continue to re-assess!
- If the initial NDC was successful, but symptoms later recur:
  - Perform another NDC at the same site that was used previously. Use a new needle/catheter unit for the repeat NDC
  - Continue to re-assess!
- If the second NDC is also not successful: continue on to the Circulation section of the TCCC Guidelines.

b. All open and/or sucking chest wounds should be treated by immediately applying a vented chest seal to cover the defect. If a vented chest seal is not available, use a non-vented chest seal. Monitor the casualty for the potential development of a subsequent tension pneumothorax. If the casualty develops increasing hypoxia, respiratory distress, or hypotension and a tension pneumothorax is suspected, treat by burping or removing the dressing or by needle decompression.
c. Initiate pulse oximetry. All individuals with moderate/severe TBI should be monitored with pulse oximetry. Readings may be misleading in the settings of shock or marked hypothermia.
d. Casualties with moderate/severe TBI should be given supplemental oxygen when available to maintain an oxygen saturation > 90%.

6. Circulation

a. Bleeding
- A pelvic binder should be applied for cases of suspected pelvic fracture:
  - Severe blunt force or blast injury with one or more of the following indications:
    - Pelvic pain
    - Any major lower limb amputation or near amputation
    - Physical exam findings suggestive of a pelvic fracture
    - Unconsciousness
    - Shock
- Reassess prior tourniquet application. Expose the wound and determine if a tourniquet is needed. If it is needed, replace any limb tourniquet placed over the uniform with one applied directly to the skin 2-3 inches above the bleeding site. Ensure that bleeding is stopped. If there is no traumatic amputation, a distal pulse should be checked. If bleeding persists or a distal pulse is still present, consider additional tightening of the tourniquet or the use of a second tourniquet side-by-side with the first to eliminate both bleeding and the distal pulse. If the reassessment determines that the prior tourniquet was not needed, then remove the tourniquet and note time of removal on the TCCC Casualty Card.
- Limb tourniquets and junctional tourniquets should be converted to hemostatic or pressure dressings as soon as possible if three criteria are met: the casualty is not in shock; it is possible to monitor the wound closely for bleeding; and the tourniquet is not being used to control bleeding from an amputated extremity. Every effort should be made to convert tourniquets in less than 2 hours if bleeding can be controlled with other means. Do not remove a tourniquet that has been in place more than 6 hours unless close monitoring and lab capability are available.
- Expose and clearly mark all tourniquets with the time of tourniquet application. Note tourniquets applied and time of application; time of re-application; time of conversion; and time of removal on the TCCC Casualty Card. Use a permanent marker to mark on the tourniquet and the casualty card.

b. Assess for hemorrhagic shock (altered mental status in the absence of brain injury and/or weak or absent radial pulse).

c. IV/IO Access
- Intravenous (IV) or intraosseous (IO) access is indicated if the casualty is in hemorrhagic shock or at significant risk of shock (and may therefore need fluid resuscitation), or if the casualty needs medications, but cannot take them by mouth.
  - An 18-gauge IV or saline lock is preferred.
  - If vascular access is needed but not quickly obtainable via the IV route, use the IO route.

d. Tranexamic Acid (TXA)
- If a casualty will likely need a blood transfusion (for example: presents with hemorrhagic shock, one or more major amputations, penetrating torso trauma, or evidence of severe bleeding)
  OR
- If the casualty has signs or symptoms of significant TBI or has altered metal status associated with blast injury or blunt trauma:
  - Administer 2 gm of tranexamic acid via slow IV or IO push as soon as possible but NOT later than 3 hours after injury.

e. Fluid Resuscitation
- Assess for hemorrhagic shock (altered mental status in the absence of brain injury and/or weak or absent radial pulse.
- The resuscitation fluids of choice for casualties in hemorrhagic shock, listed from most to least preferred, are:
  (1) Cold stored low titer O whole blood
  (2) Pre-screened low titer O fresh whole blood
  (3) Plasma, red blood cells (RBCs) and platelets in a 1:1:1 ratio
  (4) Plasma and RBCs in a 1:1 ratio
  (5) Plasma or RBCs alone

  ❖ NOTE: Hypothermia prevention measures [Section 7] should be initiated while fluid resuscitation is being accomplished.

- If not in shock:
  - No IV fluids are immediately necessary.
  - Fluids by mouth are permissible if the casualty is conscious and can swallow.

- If in shock and blood products are available under an approved command or theater blood product administration protocol:
  - Resuscitate with cold stored low titer O whole blood, or, if not available
  - Pre-screened low titer O fresh whole blood, or, if not available
  - Plasma, RBCs, and platelets in a 1:1:1 ratio, or, if not available
  - Plasma and RBCs in a 1:1 ratio, or, if not available
  - Reconstituted dried plasma, liquid plasma or thawed plasma alone or RBCs alone
  - Reassess the casualty after each unit. Continue resuscitation until a palpable radial pulse, improved mental status or systolic BP of 100 mmHg is present.
  - Discontinue fluid administration when one or more of the above end points has been achieved.

- If blood products are transfused, administer one gram of calcium (30 ml of 10% calcium gluconate or 10 ml of 10% calcium chloride) IV/IO after the first transfused product.

- Given increased risk for a potentially lethal hemolytic reaction, transfusion of unscreened group O fresh whole blood or type specific fresh whole blood should only be performed under appropriate medical direction by trained personnel.
- Transfusion should occur as soon as possible after life-threatening hemorrhage in order to keep the patient alive. If Rh negative blood products are not immediately available, Rh positive blood products should be used in hemorrhagic shock.
- If a casualty with an altered mental status due to suspected TBI has a weak or absent radial pulse, resuscitate as necessary to restore and maintain a normal radial pulse. If BP monitoring is available, maintain a target systolic BP between 100-110 mmHg.
- Reassess the casualty frequently to check for recurrence of shock. If shock recurs, re-check all external hemorrhage control measures to ensure that they are still effective and repeat the fluid resuscitation as outlined above.

f. Refractory Shock
   - If a casualty in shock is not responding to fluid resuscitation, consider untreated tension pneumothorax as a possible cause of refractory shock. Thoracic trauma, persistent respiratory distress, absent breath sounds, and hemoglobin oxygen saturation < 90% support this diagnosis. Treat as indicated with repeated NDC or finger thoracostomy/chest tube insertion at the 5th ICS in the AAL, according to the skills, experience, and authorizations of the treating medical provider. Note that if finger thoracostomy is used, it may not remain patent and finger decompression through the incision may have to be repeated. Consider decompressing the opposite side of the chest if indicated based on the mechanism of injury and physical findings.

7. Hypothermia Prevention

a. Take early and aggressive steps to prevent further body heat loss and add external heat when possible for both trauma and severely burned casualties.
b. Minimize casualty's exposure to cold ground, wind and air temperatures. Place insulation material between the casualty and any cold surface as soon as possible. Keep protective gear on or with the casualty if feasible.
c. Replace wet clothing with dry clothing, if possible, and protect from further heat loss.
d. Place an active heating blanket on the casualty's anterior torso and under the arms in the axillae (to prevent burns, do not place any active heating source directly on the skin or wrap around the torso).
e. Enclose the casualty with the exterior impermeable enclosure bag.

f. As soon as possible, upgrade hypothermia enclosure system to a well-insulated enclosure system using a hooded sleeping bag or other readily available insulation inside the enclosure bag/external vapor barrier shell.
g. Pre-stage an insulated hypothermia enclosure system with external active heating for transition from the non-insulated hypothermia enclosure systems; seek to improve upon existing enclosure system when possible.
h. Use a battery-powered warming device to deliver IV/IO resuscitation fluids, in accordance with current CoTCCC guidelines, at flow rate up to 150 ml/min with a 38°C output temperature.
i. Protect the casualty from exposure to wind and precipitation on any evacuation platform.

8. Penetrating Eye Trauma

- If a penetrating eye injury is noted or suspected:
  - Perform a rapid field test of visual acuity and document findings.
  - Cover the eye with a rigid eye shield (NOT a pressure patch).
  - Ensure that the 400 mg moxifloxacin tablet in the Combat Wound Medication Pack (CWMP) is taken if possible and that IV/IO/IM antibiotics are given as outlined below if oral moxifloxacin cannot be taken.

9. Monitoring

- Initiate advanced electronic monitoring if indicated and if monitoring equipment is available.

10. Analgesia

a. TCCC non-medical first responders should provide analgesia on the battlefield achieved by using:
   - Mild to Moderate Pain
   - Casualty is still able to fight
     - TCCC Combat Wound Medication Pack (CWMP)
       - Acetaminophen – 500 mg tablet, 2 PO every 8 hours
       - Meloxicam – 15 mg PO once a day

b. TCCC Medical Personnel*:*

   Option 1
   - Mild to Moderate Pain
   - Casualty is still able to fight
     - TCCC Combat Wound Medication Pack (CWMP)
       - Acetaminophen – 500 mg tablet, 2 PO every 8 hours
       - Meloxicam – 15 mg PO once a day

Option 2

- Mild to Moderate Pain
- Casualty IS NOT in shock or respiratory distress AND Casualty IS NOT at significant risk of developing either condition.
  - Oral transmucosal fentanyl citrate (OTFC) 800 µg
    - May repeat once more after 15 minutes if pain uncontrolled by first

TCCC Combat Paramedics or Providers:

- Fentanyl 50 mcg IV/IO 0.5-1 mcg/kg
  - May repeat q 30 min
- Fentanyl 100 mcg IN
  - May repeat q 30 min

Option 3

- Moderate to Severe Pain
- Casualty IS in hemorrhagic shock or respiratory distress OR
- Casualty IS at significant risk of developing either condition:
  - Ketamine 20-30 mg (or 0.2 - 0.3 mg/kg) slow IV or IO push
    - Repeat doses q 20min prn for IV or IO
    - End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes).
  - Ketamine 50-100 mg (or 0.5-1 mg/kg) IM or IN
    - Repeat doses q20-30 min prn for IM or IN

Option 4

TCCC Combat Paramedics or Providers:

- *Sedation required:* significant severe injuries requiring dissociation for patient safety or mission success or when a casualty requires an invasive procedure; must be prepared to secure the airway:

  - Ketamine 1-2 mg/kg slow IV/IO push initial dose
    - Endpoints: procedural (dissociative) anesthesia
  - Ketamine 300 mg IM (or 2-3 mg/kg IM) initial dose
    - Endpoints: procedural (dissociative) anesthesia

  ❖ If an emergence phenomenon occurs, consider giving 0.5-2 mg IV/IO midazolam.
  ❖ If continued dissociation is required, move to the Prolonged Casualty Care (PCC) analgesia and sedation guidelines.

- If longer duration analgesia is required:

  - Ketamine slow IV/IO infusion 0.3 mg/kg in 100 ml 0.9% sodium chloride over 5-15 minutes.

- Repeat doses q45min prn for IV or IO
- End points: Control of pain or development of nystagmus (rhythmic back-and-forth movement of the eyes).

c. Analgesia and sedation notes:
    - Casualties need to be disarmed after being given OTFC, IV/IO fentanyl, ketamine, or midazolam.
    - The goal of analgesia is to reduce pain to a tolerable level while still protecting their airway and mentation.
    - The goal of sedation is to stop awareness of painful procedures.
    - Document a mental status exam using the AVPU method prior to administering opioids or ketamine.
    - For all casualties given opioids, ketamine or benzodiazepines – monitor airway, breathing, and circulation closely.
    - Directions for administering OTFC:
        - Place lozenge between the cheek and the gum.
        - Do not chew the lozenge.
        - Recommend taping lozenge-on-a-stick to casualty's finger as an added safety measure OR utilizing a safety pin and rubber band to attach the lozenge (under tension) to the patient's uniform or plate carrier.
        - Reassess in 15 minutes.
        - Add second lozenge, in other cheek, as necessary to control severe pain.
        - Monitor for respiratory depression.
    - Ketamine comes in different concentrations; the higher concentration option (100 mg/ml) is recommended when using IN dosing route to minimize the volume administered intranasally.
    - Naloxone (0.4 mg IV/IO/IM/IN) should be available when using opioid analgesics.
    - TBI and/or eye injury does not preclude the use of ketamine. However, use caution with OTFC, IV/IO fentanyl, ketamine, or midazolam in TBI patients as this may make it difficult to perform a neurologic exam or determine if the casualty is decompensating.
    - Ketamine may be a useful adjunct to reduce the amount of opioids required to provide effective pain relief. It is safe to give ketamine to a casualty who has previously received a narcotic. IV Ketamine should be given over 1 minute.
    - If respirations are reduced after using opioids or ketamine, reposition the casualty into a "sniffing position". If that fails, provide ventilatory support with a bag-valve-mask or mouth-to-mask ventilations.
    - Ondansetron, 4 mg Orally Dissolving Tablet (ODT)/IV/IO/IM, every 8 hours as needed for nausea or vomiting. Each 8-hour dose can be repeated once after 15 minutes if nausea and vomiting are not improved. Do not give more than 8 mg in any 8-hour interval. Oral ondansetron is NOT an acceptable alternative to the ODT formulation.

- The use routine of benzodiazepines such as midazolam is NOT recommended for analgesia. When performing procedural sedation, benzodiazepines may also be considered to treat behavioral disturbances or unpleasant (emergence) reactions. Benzodiazepines should not be used prophylactically and are not commonly needed when the correct pain or sedation dose of ketamine is used.
- Polypharmacy is not recommended; benzodiazepines should NOT be used in conjunction with opioid analgesia.
- If a casualty appears to be partially dissociated, it is safer to administer more ketamine than to use a benzodiazepine.

11. Antibiotics

a. Antibiotics recommended for all open combat wounds.
b. If able to take PO meds:
    - Moxifloxacin (from the CWMP), 400 mg PO once a day.
c. If unable to take PO meds (shock, unconsciousness):
    - Ertapenem, 1 gm IV/IO/IM once a day.

12. Inspect and dress known wounds.

a. Inspect and dress known wounds.
b. Abdominal evisceration – [Control bleeding]; rinse with clean (and warm if possible) fluid to reduce gross contamination. Hemorrhage control – apply combat gauze or CoTCCC recommended hemostatic dressing to uncontrolled bleeding. Cover exposed bowel with a moist, sterile dressing or sterile water-impermeable covering.
    - Reduction: do not attempt if there is evidence of ruptured bowel (gastric/intestinal fluid or stool leakage) or active bleeding.
    - If no evidence of bowel leakage and hemorrhage is visibly controlled, a single brief attempt (<60 seconds) may be made to replace/reduce the eviscerated abdominal contents.
    - If unable to reduce; cover the eviscerated organs with water impermeable non-adhesive material (transparent preferred to allow ability to re-assess for ongoing bleeding); examples include a bowel bag, IV bag, clear food wrap, etc. and secure the impermeable dressing to the patient using adhesive dressing (examples: ioban, chest seal).
    - Do NOT FORCE contents back into abdomen or actively bleeding viscera.
    - The patient should remain NPO.

13. Check for additional wounds.

14. Burns.

a. Assess and treat as a trauma casualty with burns and not burn casualty with injuries.
b. Facial burns, especially those that occur in closed spaces, may be associated with inhalation injury. Aggressively monitor airway status and oxygen saturation in such

patients and consider early surgical airway for respiratory distress or oxygen desaturation.

c. Estimate total body surface area (TBSA) burned to the nearest 10% using the Rule of Nines.
d. Cover the burn area with dry, sterile dressings. For extensive burns (>20%), consider placing the casualty in the Heat-Reflective Shell or Blizzard Survival Blanket from the Hypothermia Prevention Kit in order to both cover the burned areas and prevent hypothermia.
e. Fluid resuscitation (USAISR Rule of Ten):
    - If burns are greater than 20% of TBSA, fluid resuscitation should be initiated as soon as IV/IO access is established. Resuscitation should be initiated with Lactated Ringer's, normal saline, or Hextend. If Hextend is used, no more than 1000 ml should be given, followed by Lactated Ringer's or normal saline as needed.
    - Initial IV/IO fluid rate is calculated as %TBSA x 10 ml/hr for adults weighing 40- 80 kg.
    - For every 10 kg ABOVE 80 kg, increase initial rate by 100 ml/hr.
    - If hemorrhagic shock is also present, resuscitation for hemorrhagic shock takes precedence over resuscitation for burn shock. Administer IV/IO fluids per the TCCC Guidelines in Section (6).
    - Consider oral fluids for burns up to 30% TBSA if casualty is conscious and able to swallow.
f. Analgesia in accordance with the TCCC Guidelines in Section (10) may be administered to treat burn pain.
g. Prehospital antibiotic therapy is not indicated solely for burns, but antibiotics should be given per the TCCC guidelines in Section (11) if indicated to prevent infection in penetrating wounds.
h. All TCCC interventions can be performed on or through burned skin in a burn casualty.
i. Burn patients are particularly susceptible to hypothermia. Extra emphasis should be placed on barrier heat loss prevention methods.

15. Splint fractures and re-check pulses.

16. Cardiopulmonary resuscitation (CPR).

a. Resuscitation on the battlefield for victims of blast or penetrating trauma who have no pulse, no ventilations, and no other signs of life will not be successful and should not be attempted.
b. However, casualties with torso trauma or polytrauma who have no pulse or respirations during TFC should have bilateral needle decompression performed to ensure they do not have a tension pneumothorax prior to discontinuation of care. The procedure is the same as described in section (5a) above.

17. Communication.

a. Communicate with the casualty if possible. Encourage, reassure and explain care.
b. Communicate with tactical leadership as soon as possible and throughout casualty treatment as needed. Provide leadership with casualty status and evacuation requirements to assist with coordination of evacuation assets.
c. Communicate with the evacuation system (the Patient Evacuation Coordination Cell) to arrange for TACEVAC. Communicate with medical providers on the evacuation asset if possible and relay mechanism of injury, injuries sustained, signs/symptoms, and treatments rendered. Provide additional information as appropriate.

18. Documentation of Care.

- Document clinical assessments, treatments rendered, and changes in the casualty's status on a TCCC Card (DD Form 1380). Forward this information with the casualty to the next level of care.

19. Prepare for Evacuation.

a. Complete and secure the TCCC Card (DD 1380) to the casualty.
b. Secure all loose ends of bandages and wraps.
c. Secure hypothermia prevention wraps/blankets/straps.
d. Secure litter straps as required. Consider additional padding for long evacuations.
e. Provide instructions to ambulatory patients as needed.
f. Stage casualties for evacuation in accordance with unit standard operating procedures.
g. Maintain security at the evacuation point in accordance with unit standard operating procedures.

Principles of Tactical Evacuation Care (TACEVAC)

* The term "Tactical Evacuation" includes both Casualty Evacuation (CASEVAC) and Medical Evacuation (MEDEVAC) as defined in Joint Publication 4-02.

Basic Management Plan for Tactical Evacuation Care

1. **Transition of Care**
    a. Tactical force personnel should establish evacuation point security and stage casualties for evacuation.
    b. Tactical force personnel or the medic should communicate patient information and status to TACEVAC personnel as clearly as possible. The minimum information communicated should include stable or unstable, injuries identified, and treatments rendered.
    c. TACEVAC personnel should stage casualties on evacuation platforms as required.
    d. Secure casualties in the evacuation platform in accordance with unit policies, platform configurations and safety requirements.
    e. TACEVAC medical personnel should re-assess casualties and re-evaluate all injuries and previous interventions.

2. **Massive Hemorrhage** (same as Tactical Field Care)

3. **Airway Management**

    Endotracheal intubation may be considered in lieu of cricothyroidotomy if trained.

4. **Respiration/Breathing**

    Most combat casualties do not require supplemental oxygen, but administration of oxygen may be of benefit for the following types of casualties:
    - Low oxygen saturation by pulse oximetry
    - Injuries associated with impaired oxygenation
    - Unconscious casualty
    - Casualty with TBI (maintain oxygen saturation > 90%
    - Casualty in shock
    - Casualty at altitude
    - Known or suspected smoke inhalation

5. **Circulation** (same as Tactical Field Care)

6. Traumatic Brain Injury

a. Casualties with moderate/severe TBI should be monitored for:
- Decreases in level of consciousness
- Pupillary dilation
- SBP should be >90 mmHg
- O2 sat > 90
- Hypothermia
- End-tidal CO2 (If capnography is available, maintain between 35-40 mmHg)
- Penetrating head trauma (if present, administer antibiotics)
- Assume a spinal (neck) injury until cleared.

b. Unilateral pupillary dilation accompanied by a decreased level of consciousness may signify impending cerebral herniation; if these signs occur, take the following actions to decrease intracranial pressure:
- Administer 250 ml of 3 or 5% hypertonic saline IV/IO bolus.
- Elevate the casualty's head 30 degrees.
- Hyperventilate the casualty.
  - Respiratory rate 20
  - Capnography should be used to maintain the end-tidal CO2 between 30-35 mmHg.
  - The highest oxygen concentration (FIO2) possible should be used for hyperventilation.
  - Do not hyperventilate the casualty unless signs of impending herniation are present. Casualties may be hyperventilated with oxygen using the bag-valve-mask technique.

7. Hypothermia Prevention (same as Tactical Field Care)

8. Penetrating Eye Trauma (same as Tactical Field Care)

9. Monitoring (same as Tactical Field Care)

10. Analgesia (same as Tactical Field Care)

11. Antibiotics (same as Tactical Field Care)

12. Inspect and dress known wounds (same as Tactical Field Care)

13. Check for additional wounds. (same as Tactical Field Care)

14. Burns (same as Tactical Field Care)

15. Splint fractures and re-check pulses (same as Tactical Field Care)

16. Cardiopulmonary resuscitation (CPR) in TACEVAC

a. Casualties with torso trauma or polytrauma who have no pulse or respirations during TACEVAC should have bilateral needle decompression performed to ensure they do not have a tension pneumothorax. The procedure is the same as described in Section (4a) above.
b. CPR may be attempted during this phase of care if the casualty does not have obviously fatal wounds and will be arriving at a facility with a surgical capability within a short period of time. CPR should not be done at the expense of compromising the mission or denying lifesaving care to other casualties.

17. Communication

a. Communicate with the casualty if possible. Encourage, reassure and explain care.
b. Communicate with medical providers at the next level of care as feasible and relay mechanism of injury, injuries sustained, signs/symptoms, and treatments rendered. Provide additional information as appropriate

18. Documentation of Care (same as Tactical Field Care)

Committee on Tactical Combat Casualty Care (CoTCCC) in 2021.

CAPT Brendon Drew, DO – Chairman
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SUMMARY OF 2021 CHANGES:

3. Massive Hemorrhage
    b. "CoTCCC-Recommended" is removed from junctional tourniquets. No specific products are recommended by the CoTCCC. End users should select any FDA-approved device that is indicated for junctional hemorrhage control.

4. Airway Management
    d. Removes Cric-Key technique as preferred option for surgical cricothyroidotomy and remove "least desirable option" from the standard open surgical technique. Units and end users should use the technique they are best trained to execute.

    Airway Notes: Removes iGel as the preferred extraglottic airway. Units may still use iGel if mission are at high elevation or evacuation is at high altitudes.

6. Analgesia – adjust Ketamine IV/IO dosing to 20-30 mg (or 0.2 – 0.3 mg/kg)

12. Inspect and dress known wounds

    b. Adds the preference of cleaning abdominal evisceration with clean and warm water if possible; clarifies guidance on conditions to attempt reduction of abdominal contents; that patient should remain NPO and NOT be administered oral medicals (Combat Wound Medication pack) and removes prolonged care considerations (now covered in separate PCC guidelines).

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Traumatic Brain Injury Management and Basic Neurosurgery in the Deployed Environment

Guidelines and recommendations for the treatment and medical management of casualties with moderate to severe head injuries in an environment where personnel, resources and follow-on care are limited.

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SUMMARY OF CHANGES

1. Clarification of the use of the Military Acute Concussion Evaluation 2 (MACE2) for mild traumatic brain injury (mTBI).
2. Clarification of the use of hypertonic saline or normal saline during resuscitation.
3. Addition of the recommendation to use quantitative pupillometry for evaluation of pupillary reactivity.
4. Addition of recommendation for Ketamine as a sedative in severe TBI.
5. Addition of recommendation for tranexamic acid (TXA).
6. Addition of recommendations to consider placement of Brain Tissue Oxygen Monitor (PbtO2) and maintaining > 20mmHg.
7. Addition of recommendation for vascular imaging of penetrating brain injuries to rule out traumatic pseudoaneurysms.
8. Changed seizure prophylaxis for TBI to make Levetiracetam the preferred agent and dilantin a third line agent given the inability to obtain drug levels in austere environments. Added in Vimpat as a second line agent for seizure prophylaxis.
9. Addition of treatment algorithms for treating elevated intracranial pressure, decreased PbtO2, or both.

Traumatic Brain Injury (TBI) & Neurosurgery in the Deployed Environment

Published by the Joint Trauma System, the DoD Center of Excellence for Trauma

IMPROVED OUTCOMES REQUIRE:

Point of Injury Care

- TCCC for life threatening injuries
- Hypotensive → Blood or TXA (2gms ≤ 3 hrs post injury)
- Normotensive → NS/ 3% Hypertonic Saline
- GCS ≤ 8 → SBP ≥ 110
- SaO2 > 90% → PaCO2 35-40 mmHg→ $ETCO_2$ 30 mmHg

Care ≤ 5 Hours Post-Injury

Who

- Penetrating head trauma
- Open skull fracture
- All moderate & severe TBI
- Mild TBI w/persistent confusion

What

- Neurosurgeon
- Advanced imaging
- Required equipment
- Critical care

Scope of TBI Casualties

14%: Combat

23% - 30%: Prehospital

30% - 45%: Hospital

Classification

Mild	GCS 13 - 15
Moderate	GCS 9 - 12
Severe	GCS 3 – 8

Monitor

- ICP < 22 mmHg
- CPP 60-70 mmHg
- PbtO2 > 20 mmHg
- Quantitative pupillometry (NPi) < 3 concerning for increased ICP

Medical Management

- Maintain normothermia
- Increase head of bed: ↑ 30°-45°
- Gastric ulcer prophylaxis

Sedation

- Propofol 20-75 mcg/kg/min
- Ketamine 2mg/kg
- Intermittent narcotics

Antiepileptic Meds

- Keppra
- Vimpat
- Phenytoin

Intracranial Hypertension

- Hypertonic Saline (3%)
- Na+ 150-160 mmol/L
- Mannitol 1g/kg Bolus (avoid in hypovolemic /hemorrhagic shock)

METRICS

GOALS

- SBP >110 mmHg
- MAP > 60 mmHg
- SaO2 >93%
- PaCO2 35-40 mmHg at every role of care

INTERVENTIONS

- Seizure prophylaxis
- Abx for open skull fractures
- NO STEROIDS
- ICP monitor placed prior to transport
- Hourly documentation of ICP/CPP & ventriculostomy drainage

Defense Health Agency
JOINT TRAUMA SYSTEM

Clinical tips based on the Traumatic Brain Injury and Neurosurgery in the Deployed Environment CPG, 2023. This CPG and others can be found at:
JTS CPGs : https://jts.health.mil/index.cfm/PI_CPGs/CPGs

TELEMEDICINE CONSULTATION OPTIONS FOR TRAUMA CARE PROVIDERS

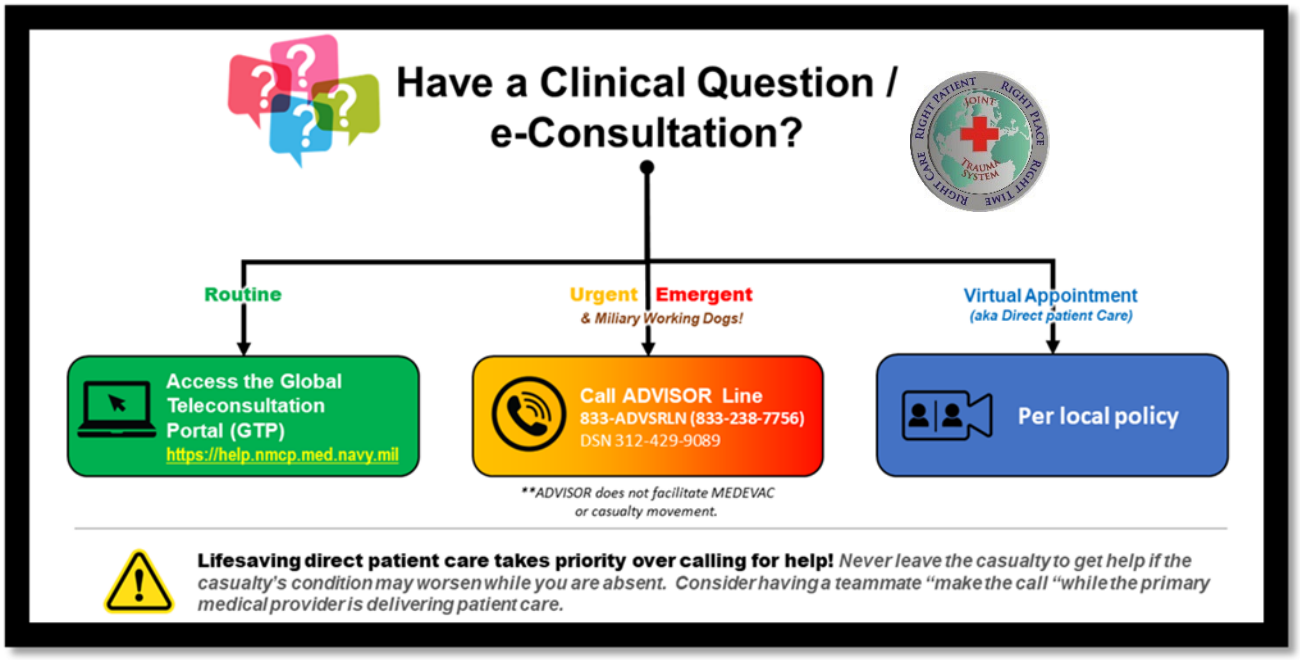
Have a Clinical Question / e-Consultation?
Routine
Urgent
Emergent
& Miliary Working Dogs!
Virtual Appointment
(aka Direct patient Care)
Access the Global Teleconsultation Portal (GTP)
https://help.nmcp.med.navy.mil
Call ADVISOR Line
833-ADVSRLN (833-238-7756)
DSN 312-429-9089
Per local policy
**ADVISOR does not facilitate MEDEVAC or casualty movement.
Lifesaving direct patient care takes priority over calling for help! Never leave the casualty to get help if the casualty's condition may worsen while you are absent. Consider having a teammate "make the call "while the primary medical provider is delivering patient care.

Illustration by Raymond Samonte

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PURPOSE

These guidelines are not intended to supplant physician judgment. Rather, these guidelines are intended to provide a basic framework for those less experienced with the delivery of care in this setting to the brain injured patient, as well as to educate and provide insight to others on the delivery of care in a restrictive environment.

BACKGROUND

Traumatic brain injury (TBI) occurs in about one third of all trauma-related deaths in the United States and remains one of the most common causes of death on the modern battlefield.[1,2] The Committee on Surgical Combat Casualty Care (CoSCCC) published a Neurosurgical Capabilities Position Statement in Feb 2023 given the importance of this issue. Specific to the combat environment:

- Positive outcomes are achieved through point of injury care to prevent secondary brain injury (avoid hypoxia, avoid hypotension), rapid evacuation from the battlefield, early medical management, timely neurosurgical intervention, meticulous critical care, and dedicated rehabilitation.[3-9]
- Optimal outcomes for severe TBI (Glasgow Coma Score [GCS] </=8) in theatre require a neurosurgical capability defined as a neurosurgeon, advanced imaging, required surgical sets, required monitoring, and critical care.
- For conflicts in Afghanistan and Iraq, Department of Defense Trauma Registry (DoDTR) data demonstrate: [10,11]
    - 14% of casualties sustained a traumatic brain injury.[10]
    - TBI was the mechanism of death for 30% of prehospital deaths from 2001 to 2011 and 45% of hospital deaths from 2001 to 2009.[12]
    - From 2014 to 2021 Armed Forces Medical Examiner System (AFMES) data demonstrate TBI accounted for 23% of prehospital deaths and 30% of hospital deaths (Unpublished JTS-AFMES data).
    - Over 5,600 neurosurgical procedures were performed in-theater between 2002-2016.[12]
    - Casualties with a TBI and an indication for neurosurgical intervention were more likely to survive if they received surgery within 5 hours of injury.[9]
    - Neurosurgical interventions performed on the battlefield after penetrating injuries result in improved survival.[13]
- Severe TBI also occurs during routine and crisis contingency operations, both ground and maritime combat, with an associated mortality of 69.7%.
- The incidence of TBI after non-combat maritime mass casualty events such as collisions is 5.8%; during modern naval warfare when warships are attacked by missile strikes or other explosive devices, the incidence of severe TBI is 17.2%.[14]
- Some patients with severe closed and penetrating brain injury had favorable outcomes when treated in military medical treatment facilities (MTFs) and received timely and aggressive neurosurgical and neuro-critical care interventions.[2-5,9]

CLASSIFICATION

The classification of brain injury informs prognosis and care eligibility in the combat environment. Brain injury severity is classified according to their **GCS.**

Table 1. Glasgow Coma Score

GLASGOW COMA SCORE	EYE OPENING	BEST VERBAL EFFORT	BEST MOTOR EFFORT
1	None	None	Flaccid
2	To Pain	Nonspecific sounds	Decerebrates to pain
3	To verbal stimuli	Inappropriate words	Decorticates to pain
4	Spontaneous	Confused	Withdraws to pain
5	-	Oriented	Localizes to pain
6	-	-	Follows commands

- Mild: GCS 13-15
- Moderate: GCS 9-12
- Severe: GCS 3-8

Neurosurgical care capabilities are available at designated Role 3 facilities, Role 4 facilities and in pre-identified partner nation facilities.

ROLE 3 TRANSFER FOR NEUROSURGICAL EVALUATION & CARE

Neurosurgical care in a combat theater is a limited resource and often requires air transport to get patients to the closest neurosurgeon or even Computed Tomography (CT) for diagnosis and treatment. Both over- and under-utilization should be avoided.

COALITION CASUALTIES

- Coalition casualties may require transfer for formal evaluation with a CT scan and/or a neurosurgeon when they:
  - continue to have a GCS < 14 (mild TBI needs further evaluation in coalition casualties if the GCS does not return to GCS of 15).
  - are confused or have continued cognitive deficits.
- The MACE2 is validated for determining the presence of an mTBI and should be used as an initial screening tool for to evaluate mTBI. It should not be used to determine worsening intracranial injury.[15-17]
- All coalition casualties should be referred for neurosurgical evaluation if they have:
  - Penetrating brain injury
  - Open skull fracture
  - Moderate or severe brain injury
  - Head trauma AND unexplained neurologic deficits

HOST NATION (HN) CASUALTIES

- Management of host nation casualties should be in accordance with medical rules of eligibility (MEDROE) established for the area of responsibility. TBI management and neurosurgical care of HN casualties are MEDROE dependent. Providers should care to the best of their capabilities for HN TBI patients and involve the theater Trauma Medical Director (TMD) and neurosurgery (NS) early in the management.
- When MEDROE permits, moderate brain injury in HN casualties should be referred to Role 3 facilities with neurosurgical capability for definitive care.
- All patients should ethically receive equal care; however, the realities of combat are that HN casualties with severe brain injury have a poor prognosis when follow-on care is not available after discharge from the military MTF. The decision to transfer HN casualties with severe brain injury to Role 3 is based on mission, tactical situation, and resource availability and is ideally preceded by direct communication and discussion with the TMD and neurosurgeon.
- Depending on the severity of TBI, considerations for transfer of HN casualties to HN facilities after Role 3 MTF care can be complicated, multifactorial, and dependent on current MEDROEs. HN patients may not receive optimal care after leaving the military MTF, which adds to the complexity of decision-making for the care of these patients. For patients with severe TBI and poor prognosis, palliative care at the in-theatre MTF may be most appropriate. These decisions should be made in the context of TBI severity and the available continuum of care for the patient in their nation of origin. Discussions with the theater neurosurgeon, TMD, and command elements can aid in this difficult decision.

EARLY EVALUATION & TREATMENT

The initial management of the patient with brain trauma begins with addressing life-threatening injuries and resuscitation in accordance with Tactical Combat Casualty Care (TCCC) guidelines in the field for corpsmen and combat medics or Advanced Trauma Life Support (ATLS) providers.[18]

Initial severe TBI treatment:
- *3% NaCl 250cc over 15 min*
- *Antiepileptics (Keppra 1500mg IV loading dose)*
- *TXA 2gm (if ≤ 3 hours post-injury)*
- *Antibiotics if open skull fracture*

- **Simple physical interventions to implement early:**
  - Head of bed elevated to 30-45 degrees or reverse Trendelenburg (if in spinal precautions)
  - Keep head straight to avoid kinking of the internal jugular veins (to promote venous drainage)
  - Avoid tight cervical collars and tight circumferential endotracheal tube/tracheostomy tube ties
- **Imaging**: Patients with a suspected traumatic brain injury with altered mental status (GCS 12 or less) should have a non-contrast head CT as soon as possible. For penetrating head injuries, in addition to the non-contrast head CT study, a CT angiogram of the brain should also be obtained to evaluate for vascular injuries (e.g., pseudoaneurysms).
- **Blood products** are the **preferred resuscitative fluid for hypotension in all trauma patients**. Avoid Albumin and hydroxyethyl starches; albumin is associated with worse outcomes when used in TBI patients.[19,20]

- **Tranexamic acid:** All patients with evidence of moderate or severe TBI should be administered 2gm of TXA within 3hrs of injury; 2gm of TXA in TBI patients improves survival.[21,]
- **If severe TBI is suspected, antiepileptics (Keppra, 1500 mg loading dose) should be administered during the initial evaluation and within 30 minutes of arrival.**
- **For casualties with abnormal GCS who do not require resuscitation** for hypotension or major blood loss, use normal saline or 3% hypertonic saline for volume resuscitation. Both have shown equivalent outcomes in severe TBI. **Avoid hypotonic fluids (e.g., any IVF with Dextrose % in water [D5W]**).
- **For casualties with GCS ≤ 8**, manage hypotension by maintaining systolic blood pressure greater than 110 mmHg.[22] A **systolic blood pressure of less than 90mmHg is the single risk factor most highly associated with mortality in brain trauma**.[23,24]
- **End tidal CO_2 ($ETCO_2$)** should be monitored during prehospital care and continued after handoff to a surgical team. Normoventilation with a goal partial pressure of carbon dioxide **($PaCO_2$) of 35-40 mmHg should be maintained or $ETCO_2$ of 30 mmHg.**
- **Prophylactic hyperventilation is not recommended** as it decreases cerebral blood flow. It may be used as a temporizing measure to reduce intracranial pressure in the setting of suspected herniation until other therapies are employed to decrease intracranial pressure as the patient is on the way to the operating room.[25] Hyperventilation can be harmful. [22]
- **For penetrating brain injuries and open skull fractures, routine prophylactic antibiotics** are indicated.[26] Antibiotic recommendations for the first level of surgical care include either cefazolin 2gm IV every 6-8 hours or clindamycin 600mg IV every 8 hours. If a penetrating head injury appears grossly contaminated with organic debris, consider addition of metronidazole 500mg IV every 8-12 hours.[26]
- **For isolated closed head injuries**, routine prophylactic antibiotics are not indicated.
- **Hypoglycemia and hyperglycemia must be avoided. Monitor glucose** every 6 hours. The goal is to maintain glucose < 180 mg/dl and avoid hypoglycemia.[27] **D5W IVF** will **worsen cerebral edema**. **Do NOT use intravenously** to maintain euglycemia.
- **Steroids should be avoided in brain-injured patients** as they have not shown outcome benefit and increase mortality in patients with severe brain injury.[25,28]
- **A common strategy for management of hypoxemia** has been a goal of arterial oxygen saturation (SaO2) >90% and the partial pressure of oxygen in the arterial blood (PaO2) >60 mmHg.[24] However, in order to establish a safety buffer in the deployed setting often characterized by frequent patient handoffs and occasional equipment challenges, a **goal SaO2 of 93-95% and PaO2 >80mmHg**, is recommended. Particular attention to avoidance of hypoxemia during air transport is essential as human studies and animal models indicate hypoxia during aeromedical evacuation is common.[29,30]
- **Document serial neurological exam findings every hour**, including:
  - Glasgow Coma Score broken down by eyes, voice, motor scores. (See Table 1.)
  - Presence of gross focal neurologic signs and/or deficit.
  - Pupil size and reactivity. See below Figures 1 and 2.
  - When available, quantitative pupillometry should be assessed and documented to ensure accuracy and consistency of recordings.[31-33] Quantitative pupillometry and the neurologic pupillary index (NPi) allows objective and consistent assessment of pupillary reactivity to track

trends and determine if a patient's responsiveness is worsening. ICU nurses should be documenting these findings and they should be trended.

- NPi < 3.0 is concerning for an abnormal or sluggish pupil and therefore increased intracranial pressure. NPi should be documented and significant changes indicate the need to assess or empirically treat for increased intracranial pressure. If a neurosurgeon is not managing the patient; telehealth support to review NPi should be considered. (See Appendix D.)

Figure 1. Pupillometer

Figure 2. Pupillometer in Use

MEDICAL MANAGEMENT

SEDATION

There is a delicate balance when sedating patients with TBI. When transferring casualties to a neurosurgical capability for initial assessment, avoid long-lasting sedation or paralysis as this impedes the ability to evaluate the patient. However, medication selection should not override the need to safely transport the casualty.

- Propofol can be used for sedation, but caution must be used to avoid hypotension.[25]
- Ketamine is also useful for sedation (and can also provide some analgesia) as it avoids the significant hypotension associated with propofol and there is evidence it lowers intracranial pressure (ICP).[34-40]
- When narcotics are utilized for pain management, intermittent narcotic doses are preferred over continuous infusion.
- Routine paralysis of TBI patients should be avoided. If paralytics are needed, vecuronium is preferred because it is readily available in the austere environment and does not require refrigeration. Bolus dosing is preferred over continuous infusion. The recommended initial dose is 0.08 to 0.1 mg/kg given as an intravenous bolus injection. Paralytics should only be used if the patient is appropriately sedated. In general, paralytics should only be used for high-risk transport.

INTRACRANIAL HYPERTENSION

Despite controversy on the use of invasive monitoring to measure ICP, treatment of known or suspected intracranial hypertension remains a cornerstone of therapy in patients with severe brain injury.[42]

Intracranial hypertension should be suspected based on certain clinical criteria if no CT scan or intracranial monitor is available. These criteria include:

- GCS Motor Score < 4
- Pupillary asymmetry
- Interval development of pupillary asymmetry ≥ 2mm
- Abnormal pupil reactivity
- Decrease of motor score by ≥ 1
- New motor deficit
- Hypertension with Bradycardia
- If an automated pupillometer is present, an NPi < 3 on one or both eyes is concerning for raised intracranial pressure.

If treatment for intracranial hypertension is indicated prior to arrival to a neurosurgical capability, initiate hyperosmotic therapy with one of the following:

1. **Hypertonic Saline**[42,43] (Appendix B)
   - 250ml bolus of 3% saline administered over 10-15 minutes or a 30cc bolus of 23.4% saline.
   - In a location with no neurosurgical capability for definitive treatment, infuse 3% saline at 50-100ml/hr for resuscitation with goal serum Na level of 150-160mmol/L. If in the rare circumstance, chronic hyponatremia is suspected, elevation of plasma sodium by 3-5mmol/L over 2-4 hours is recommended.
   - Place central venous access to administer hypertonic saline and vasoactive medications, particularly if it is anticipated to be needed long term. Subclavian veins are preferred, followed by femoral, and lastly internal jugular.
2. **Mannitol**

   Avoid Mannitol during the initial resuscitation period when ongoing bleeding has not been ruled out and in hypotensive casualties (or any casualty with the risk of bleeding).

   Consider using Mannitol only if there is no availability of hypertonic saline and there is a significant concern for imminent herniation as evidenced by signs of intracranial hypertension described above.
   - Mannitol 1g/kg bolus IV.[25]
   - Hypotension after mannitol administration must be predicted and avoided. Urine output should be replaced with isotonic fluids.
   - When treating patients with osmotic agents, monitor serum sodium at least every 6 hours.

ANTIEPILEPTIC MEDICATIONS AND SEIZURES

Seizures are common after severe brain trauma. **Administer seizure prophylaxis** to avoid the hemodynamic changes and increased cerebral metabolic activity caused by seizures. Seizure medications help prevent early post-traumatic seizures, but do not prevent all seizures. Up to 25% of patients with severe TBI will have seizures even with prophylactic treatment. Fifty percent of seizures may be non-convulsive in nature. Patients with subdural hematoma, neurosurgical procedure, or penetrating brain injury are at the highest risk of seizures. Post-traumatic seizures have been shown to increase morbidity and mortality after trauma.[44-47]

- **If severe TBI is suspected, seizure prophylaxis should be administered during the initial evaluation and within 30 minutes of arrival.**
  - **Preferred agent:** Levetiracetam (Keppra) 1500mg IV loading dose, followed by 1000mg IV BID
  - **Second line agent:** Lacosamide (Vimpat) 400mg IV loading dose, followed by 200mg IV q12hours.
  - Continue seizure prophylaxis for 7 days after a moderate or severe TBI.[25,48-52] (Appendix A)
  - Seizure medications should be continued past post-injury day seven if the patient had evidence of seizure activity.
  - Rapid assessment and treatment of seizures is important to prevent secondary neurologic insult. Use a rapid response EEG device (if available) to diagnose seizures accurately and quickly.[54-58]
- **Active Seizures**

  Lorazepam 1-2mg IV or Midazolam 5-10mg IV. Lorazepam is preferred. If no IV access, Midazolam IM is as effective as Lorazepam IV

OTHER PRECAUTIONS

- Maintain normothermia. Avoid and treat hyperthermia.
- Elevate head of bed to 30-45° or use reverse Trendelenburg position for suspected concomitant spine/spinal cord injuries.
- Gastric ulcer prevention with an IV PPI should be started within 12 hours of admission.
- Consider enteral nutrition according to Nutritional Support Using Enteral and Parenteral Methods.[59]

AEROMEDICAL EVACUATION CONSIDERATIONS

Coordinating care between sending and receiving physicians is of paramount importance during patient movement. Neurosurgeons should discuss all patients being transferred to Role 4 with the receiving neurosurgical team to ensure a common understanding of the patient and the risks and benefits of aeromedical evacuation. Casualties with severe TBI should be manifest with altitude restrictions and the cabin pressured to 5000ft. PaO2 and SaO2 should be closely monitored in flight given the risk of barometric changes in PaO2.

INTRACRANIAL PRESSURE

ICP monitoring is recommended during aeromedical evacuation for patients who would meet the requirements stated below in the surgical management section.[61]

If appropriate neurosurgical capability and bed capacity are available, observation in theater may be warranted for patients with borderline ICP measurements. Stresses of flight including vibration, temperature, noise, movement, light, hypoxia, and altitude have been shown to increase ICP.[62,63]

Delayed evacuation may improve outcomes in patients with ongoing resuscitation needs and intracranial hemorrhage or decreased GCS. Since most intubated patients require heavy sedation and often paralysis during transport, neurologic exam cannot be followed and a neurologic deterioration may not be detected for many hours. Some patients have suffered herniation during long range evacuation. For example, this has occurred with patients who have significant burns requiring resuscitation who have intracranial hemorrhage or cerebral edema.

Do not remove a functional ICP monitor in the immediate period prior to aeromedical evacuation. This provides information to the Critical Care Air Transport Team (CCATT) team that can direct in flight treatment. Furthermore, it offers a level of safety in terms of stable ICP in patients who may otherwise require sedation or not have a reliable neurological exam.

DRAINS

Do not remove drains in the immediate period prior to aeromedical evacuation due to the risk of bleeding.

PNEUMOCEPHALUS

The effect of increasing altitude on contained air within the body, including the cranium, will potentially result in expansion of pneumocephalus; this is particularly true for those who have not undergone a decompressive craniectomy prior to the flight.

All patients should be transported with head of bed elevation or reverse Trendelenberg at 30-45°. Typically U.S. Air Force doctrine is to load all patient's feet first into the aircraft.[62] In a patient with TBI, the **aeromedical transport physician may consider loading headfirst, to maintain head elevation during flight**.

DEEP VEIN THROMBOSIS PROPHYLAXIS

All patients should be started on mechanical Deep Vein Thrombosis (DVT) prophylaxis at a minimum using sequential compression devices on uninjured extremities.

All trauma patients who are non-ambulatory require DVT prophylaxis, including brain-injured casualties. Chemical DVT prophylaxis in all moderate to severe head injured patients with normal coagulation profile should be started once there is a documented stable head CT, ideally no later than 24 hours after injury.

Caution in starting DVT prophylaxis and discussion with neurosurgeon is recommended for the following conditions:

- Polytrauma with or at risk for coagulopathy.
- Have intracranial monitor/drain in place.

- Have one or more of the following TBI features that are "high risk" for progression according to the Norwood-Berne criteria:
  - Subdural hematoma (SDH) ≥ 8mm
  - Epidural hemorrhage ≥ 8mm
  - Largest single contusion ≥ 2cm
  - More than one contusion per lobe
  - Diffuse or scattered subarachnoid hemorrhage.
  - Diffuse or scattered intraventricular hemorrhage.

For these patients, chemical prophylaxis may be started 72 hours post-injury or as neurosurgeon recommends (reference) [64,65]

Enoxaparin 30mg subcutaneous BID (preferred) or subcutaneous heparin, 5000U TID may be used as chemoprophylaxis.[25,66-68]

MULTIMODALITY MONITORING OF HEAD INJURIES

Non-operative management of intracranial hemorrhage requires neurosurgical consultation, repeat imaging until CT scan is stable, and serial exams.

Surgical intervention may be indicated in the management of patients with severe brain injury. This includes operative care such as evacuation of space-occupying hematomas via craniectomy or craniotomy as well as placement of multimodal intracranial monitors.

INTRACRANIAL PRESSURE MONITORING

Management of **severe TBI patients** using information from ICP monitoring is recommended. Although long-term outcomes have not been shown to be improved with ICP monitoring, there is evidence that in-hospital and two-week post-injury mortality is improved.[22] Additionally, the military trauma system may require multiple patient movements and handoffs that decrease the ability to follow neurologic exams. Therefore, ICP monitoring may detect a deterioration that would normally be detected on serial neurologic exam in a stable ICU environment.

ICP monitoring should be considered in all salvageable patients with:

- Severe TBI and abnormal CT showing one or more of the following:
  - hematoma
  - contusion
  - edema
  - herniation
  - compressed basal cisterns.[25]
- Severe TBI and a normal CT if 2 or more of the following are noted:
  - Age >40
  - Unilateral or bilateral posturing
  - Systolic blood pressure <90 mm Hg.[25]

Additionally, a **low threshold for ICP monitoring** should be maintained in severe TBI patients with **any abnormal head CT and inability to follow serial neurologic exam** such as during other surgical interventions required early after injury, long-range evacuation of intubated patients, etc.

Options for ICP monitoring:[25]

- External ventricular drain (ventriculostomy tube)
- Parenchymal ICP monitors. Codman ICP monitors are the only intraparenchymal device with aeromedical certification approved for U.S. Air Force aircraft.

If using antibiotic impregnated ventriculostomy, then no IV prophylactic antibiotics required. Otherwise, Ancef 1gm IV TID may be prescribed while ventriculostomy is in place (neurosurgeon's discretion).
The goal ICP is <22 mmHg.[25]

CEREBRAL PERFUSION PRESSURE

Cerebral perfusion pressure is defined as: CPP = MAP-ICP. [22] The goal cerebral perfusion pressure (CPP) is between 60-70 mmHg when the autoregulator status of the patient is uncertain.

BRAIN TISSUE OXYGEN MONITORING

- Aeromedical evacuation may decrease continuous brain tissue oxygen (PbtO2).[33,69,70] There is evidence that the combined management of PbtO2 and ICP may improve outcomes of neurologic function in patients with severe TBI.
- Consider placement of a multi-modality intra-parenchymal catheter for monitoring of both PbtO2 and ICP
- PbtO2 should be maintained greater than 20mmHg.
- Strategies for managing PbtO2 and ICP are outlined in Appendix A under Treatment Paradigms Operative Care by Neurosurgery based on CT results: Evacuation of Hematoma.

INDICATIONS FOR NEUROSURGICAL INTERVENTION

EPIDURAL HEMATOMA

All epidural hematomas > 30cc should be surgically evacuated regardless of the patient's GCS.[25]

EDH <30cc and with less than 15mm thickness and less than 5mm midline shift with a GCS >8 without a focal deficit may be managed non-operatively with appropriate monitoring in the ICU setting. These patients should be urgently transported to an MTF with neurosurgical capability for monitoring in case they decompensate.

SUBDURAL HEMATOMA

Craniotomy for evacuation of an acute SDH with a thickness >10mm or midline shift > 5mm regardless of the patient's GCS.

Craniotomy for evacuation of acute SDH with a thickness <10mm and shift <5 mm is indicated when there is a decrease in GCS of 2 or more, worsening pupillary exam, and/or and ICP greater than 20mm Hg. [25]

TRAUMATIC PARENCHYMAL LESION

Craniotomy for evacuation of a hematoma is indicated in a patient with GCS of 6-8 with frontal or temporal contusions greater than 20 cc in volume with midline shift or at least 5mm and/or cisternal compression on CT. [25]

Craniotomy for evacuation of a hematoma is also indicated in patients with lesions greater than 50 cc in volume in a salvageable patient.

POSTERIOR FOSSA MASS LESION

Mass effect on non-contrast CT or with neurological dysfunction or deterioration due to the lesion should undergo operative intervention as soon as possible. [25]

TRAUMATIC ANEURYSMS

A high index of suspicion is required for penetrating injuries of the skull base or across known major vascular territories. All penetrating brain injuries should undergo a CT Angiogram or Digital Subtraction Angiogram to rule out or diagnose a traumatic aneurysm as soon as possible.[8]

DEBRIDEMENT

Removal of devitalized brain tissue is an option in penetrating head injuries and in select cases of open skull fractures.[71]

FOREIGN BODY REMOVAL

The routine pursuit of individual foreign bodies (e.g., bullets, metallic fragments, bone) within the brain may cause additional tissue damage and is generally not advisable but should be left to the discretion of the neurosurgeon. Removal of fragments from the sensory, motor, or language cortex may reduce the risk of posttraumatic epilepsy.[72]

DURAL MANAGEMENT

Primary dural closure or limited duroplasty should be done in extremely limited instances as cerebral edema can progress in both severe and penetrating traumatic brain injury. Commonly, duragen or other dural substitute should be used as an overlay in the vast majority of cases during a decompressive hemicraniectomy. Dura can be reconstructed with temporalis fascia or fascia lata if a dural substitute is not available.[71]

DECOMPRESSION

Surgical decompression, or craniectomy, should be strongly considered following penetrating combat brain trauma.[5,73,74]

The kinetics of combat trauma can be very different from that seen in the civilian setting. The muzzle velocities of military rifles are much higher than civilian handguns which may lead to cavitation and surrounding devitalized tissue. Additionally, blasts can create four to five different classes of injury to the brain and other organ systems complicating management.[75]

1. Primary blast injury: blast overpressure from pressure waves.
2. Secondary blast injury: penetrating fragmentation injuries.
3. Tertiary blast injury: displacement of the casualty or blast debris that falls on the casualty.
4. Quaternary blast injury: injury from the thermal effect or release of toxins from the blast.

During transport, interventions for intracranial hypertension are limited to medical management. Craniectomy and en route monitoring devices may facilitate earlier CCATT transport of patients out of theater, however **long-range evacuation is not a benign intervention** and may increase secondary brain injury. **In cases of elevated ICP or in the early postoperative period, patients may be better served by delayed evacuation if possible.**

SKULL FLAP MANAGEMENT

Options for U.S. and Coalition Patients:

1. Those who have penetrating brain trauma: Do not save or send the calvarium as alloplastic reconstruction techniques are used for these casualties.
2. Those who have blunt trauma: Consider abdominal subcutaneous implantation of the calvarial flap for later reconstruction if it can be done in a sterile fashion.

Options for Host Nation Patients:

1. Clean and replace.
2. Clean and replace with hinge craniectomy. This involves partial fixation of the superior aspect of the bone flap, allowing it to "hinge" outward to accommodate swelling.[76]
3. Craniectomy with potentially limited chances for cranioplasty in the future, depending on local rules of eligibility.
4. In some locations, low temperature tissue freezing may be possible to allow replacement at a later time.

EXPLORATORY BURR HOLES (if no neurosurgeon or CT scan is available)

Exploratory burr holes have limited practical utility. They should **only be performed by a neurosurgeon or after consultation with a neurosurgeon** if possible and at a location where CT scan is not available to better guide management. Refer to the CPG entitled Emergency Life-Saving Cranial Procedures by Non-Neurosurgeons in Deployed Setting for additional guidance.

ICP MONITORING AND SURGICAL INTERVENTION (for Host Nation Patients)

Decisions to place ICP monitors or operate on host nation nationals should consider the available resources in the host nation for long-term care and rehabilitation.

PERFORMANCE IMPROVEMENT MONITORING

POPULATION OF INTEREST

- All patients with a diagnosis of traumatic brain injury and an initial GCS of 3-8.
- All patients who receive a cranial procedure (ICP monitor, craniectomy, craniotomy).

INTENT (EXPECTED OUTCOMES)

- All patients in population of interest avoid hypotension and hypoxia: SBP never < 110 mmHg, MAP never < 60mmHg, SaO2 never < 93%.
- All patients in population of interest have $PaCO_2$ monitored at every role of care; PaCO2 should not be >40mmHg or <35mmHg.
- All patients in population of interest have a head CT performed within 4 hours of injury and surgical intervention (if necessary) within 5 hours of injury.
- All patients with a ventriculostomy have hourly documentation of ICP/CPP and ventriculostomy output.
- All patients in population of interest who are unable to be monitored clinically (e.g., unable to hold sedation for Q1 hour neuro exam) have an ICP monitor or ventriculostomy placed prior to transport out of theater.

PERFORMANCE/ADHERENCE METRICS

- Number and percentage of patients in the population of interest with lowest SBP<110 within first 3 days after injury.
- Number and percentage of patients in the population of interest with MAP<60 within first 3 days after injury.
- Number and percentage of patients in the population of interest with SaO2<93% within first 3 days after injury.
- Number and percentage of patients in population of interest who have $PaCO_2$ documented at every role of care (POI, POI MEDEVAC, Role 2-4, interfacility MEDEVAC).
- Number and percentage of patients in the population of interest who maintain $PaCO_2$=35-40mmHg.
- Number and percentage of patients who had a head CT performed within 4 hours of injury.
- Number and percentage of patients who had a craniectomy performed within 5 hours of injury.
- Number and percentage of patients with a ventriculostomy who had hourly documentation of ICP/CPP and ventriculostomy output.
- Number and percentage of patients in the population of interest unable to be monitored clinically (e.g., unable to hold sedation for Q1 hour neuro exam) who have an ICP monitor or ventriculostomy placed prior to transport out of theater.

INTENT (EXPECTED OUTCOMES)

- Keep SBP > 110 mmHg, MAP > 60mmHg and SaO2 > 93% to prevent secondary brain injury.
- Steroids are not used on head injury patients.
- Hourly documentation of ICP/CPP and ventriculostomy output documented in medical record.
- Patients in whom neurological status cannot be monitored clinically and patients with severe TBI will have ICP or ventriculostomy placed prior to transport out of theater.
- Head CT completed within 4 hours of injury for moderate and severe TBI (may require patient transfer for CT).
- When neurosurgical intervention is indicated, it is started within 5 hours from injury.
- Antibiotics will be administered to patients with open head injuries as referenced above (as outlined in Infection Prevention in Combat-related Injuries CPG).

PERFORMANCE/ADHERENCE MEASURES

- SBP >110 mmHg, MAP >60mmHg, and/or SaO2 >93% documented upon discharge.
- Steroids were not administered.
- Neurological assessment and documentation of ICP/CPP and ventriculostomy output were recorded hourly in the ICU with pupillary exams. If used data from quantitative pupillometer including NPi added to the medical record.
- Patients in whom neurological status cannot be monitored clinically, and patients with severe TBI had ICP or ventriculostomy placed prior to transport out of theater.
- Patients with moderate to severe TBI had head CT performed.
- Patients with open skull fractures received prophylactic antibiotics.
- Patients were started on DVT chemoprophylaxis or a specific reason for no prophylaxis was noted.
- Sodium goal for patient documented.
- Seizure prophylaxis started for all moderate to severe TBI patients.
- Normothermia maintained.

DATA SOURCE

- Patient Record
- DoDTR
- ICU flow sheet
- Neurologic assessment flow sheet

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance, and PI monitoring at the local level with this CPG.

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APPENDIX A: GENERAL INDICATIONS

MONITORING & LABS	GENERAL INDICATIONS*
INTRACRANIAL PRESSURE (ICP)/ BRAIN TISSUE OXYGEN	Glasgow Coma Score of 3-8 with an abnormal CT scan (hematomas, contusions, edema, or compressed basal cisterns) or 2 or more of the following adverse features are present in a patient with severe head injury and a normal head CT scan: (Age > 40 years, Unilateral or bilateral motor posturing, systolic blood pressure < 90 mmHg).
ARTERIAL LINE	Any head trauma that requires tracheal intubation and/or for other medical indications.
CENTRAL VENOUS PRESSURE	When ICP or CPP management requires anything beyond simple measures and/or for other medical indications. Trendelenburg position will raise ICP. Line site of choice is subclavian, then femoral, lastly internal jugular
EXHALED CO2	Desirable when active measures are required to control ICP. Correlate to $PaC0_2$ initially/periodically.
NEUROIMAGING	Non-contrast head CT upon admission then within 24 hours after admission (or earlier to document stability of the bleed). Additional scans obtained as indicated (e.g. clinical deterioration). Penetrating head injuries should undergo CTA or DSA if available to evaluate for vascular injury.
LABS	ABG, CBC, Chem 10, TEG, PT, PTT, and INR at least q8 hrs during the acute phase.
GENERAL MANAGEMENT PRINCIPLES*	
PHILOSOPHY	▪ Maintain continuous communication between the care teams. ▪ Maintain the patient in a "hyperosmolar-but-euvolemic" state with adequate oxygen carrying capacity and a constant substrate delivery via adequate CPP of >60mm Hg. Unless a MAP Challenge shows intact cerebral autoregulation then CPP > 70 mmHg. ▪ Aggressively avoid hypotension, hypoxemia, fever (>99 F), hyponatremia and other CNS insults. ▪ The longer the ICP is elevated (> 22), and the MAP & CPP are low (< 60), and PbtO2 < 20 the worse the outcome! ▪ Brain injury is heterogeneous amongst patients and the process is dynamic: Treatment and management goals must be tailored accordingly
RESUSCITATION FLUID	Normal saline (0.9%) or 3% hypertonic saline.
MAINTENANCE FLUID	Normal saline (0.9%)
SEDATION	Propofol 1st choice up to 72 hours. Other short-acting agents (Fentanyl, Versed) upon discretion of SICU or neurosurgical staff. Typical ICU **Propofol sedation dose range: 20-75 mcg/kg/min**. **Ketamine can also be considered** with dosages of **2mg/kg boluses for persistent elevated ICP** and/or with a continuous infusion.
ULCER PROPHYLAXIS	All patients.
DVT PROPHYLAXIS	Recognize high DVT risk in traumatic brain injury patients. Sequential Compression Device (SCD) and DVT prophylaxis should be started as soon as possible after a stable CT scan and in consultation with the theater Neurosurgeon.

MONITORING & LABS	GENERAL INDICATIONS*
SEIZURE PROPHYLAXIS	▪ Prophylactic anti-epileptic treatment is required for all severe traumatic brain injuries for 7 days if no seizure activity is documented. Keppra is the best choice for initial seizure prophylaxis. Vimpat (lacosamide), followed by Phenytoin or Fosphenytoin are second and third-line agents respectively. Given the narrow therapeutic index, multiple drug-drug interactions, and inability to obtain serum levels at Role III Facilities, Phenytoin should be used as a last resort if there are continued observed seizures, or there is a high suspicion of non-convulsive status epilepticus. ▪ Loading doses of Keppra in 20mg/kg followed by 1000 mg BID. ▪ Vimpat loading dose of 400mg IV, followed by 200mg IV q12hrs. ▪ Phenytoin can be dosed as 20 mg/kg infused at <50 mg/min or Fosphenytoin 20 PE (Phenytoin equivalent)/kg infused at <150 PE/min. The daily dose thereafter is 300 mg Phenytoin or 300 PE Fosphenytoin q HS or may be divided TID. Levels should be checked if available 30min after the loading dose and corrected for serum albumin should be between 10-20μg/mL. Dosing should then be 100mg TID and levels maintained at 10-20μg/mL.
ACUTE SEIZURE TREATMENT	Treat acute seizure with Lorazepam 1-2 mg IV or Midazolam 5-10 mg IV. Lorazepam is preferred for IV control. If no IV access is available, Midazolam IM is as effective as Lorazepam IV.
ANTIBIOTICS	If using antibiotic impregnated ventriculostomy, then no IV prophylactic antibiotics required. Otherwise, Ancef 1 gm IV TID while ventriculostomy is in place (neurosurgeons' discretion). For all penetrating head trauma, use cefazolin (see 3, a. 6) above.
NURSING	Hourly neurologic assessments. Document ICP/CPP and ventriculostomy output. Notify physician of all pertinent changes.
STEROIDS	Steroids are not recommended for head or spine trauma and should not be used.
NUTRITION	Enteral feeding should be begun as soon as it is safe to do so. Avoid agitation/ ICP during nasal or oral tube placement. Full enteral nutritional goal ≤ 7 days.

GENERAL MANAGEMENT GOALS (Goals may be individualized / altered by faculty according to specific patient requirements)*			
NEUROLOGIC	ICP	< 22 mm Hg	See page 13.
	PbtO2	> 20	
	CPP	> 60 mm Hg	
HEMODYNAMIC	Mean BP	Maintain to avoid ↓BP	▪ Hypotension (SBP < 90mmHg) worsens mortality. ▪ Provide a rapid physiologic resuscitation
	CVP	> 5 mm Hg	
PULMONARY	Sp02%	> 93%	Aggressive avoidance of hypoxemia
	$PaCO_2$	35 – 40 mmHg in first 24 hrs/	Avoid routine hyperventilation
HEMATOLOGIC	INR	≤ 1.3	Fresh frozen plasma
	Platelets	≥ 100,000/mm^3	Platelets
	TEG	Normalized values	As indicated by results
METABOLIC	Glucose	> 80 < 150 mg/dl	Have low threshold for insulin drip; avoid D5W IVF
RENAL	Serum Osmolarity	> 280 & < 320 mOsm	See Sodium Disorders, the bottom table in this general table.
	Serum Sodium	> 138 & < 160 meq/L	

INTRACRANIAL PRESSURE MANAGEMENT*	
GENERAL MEASURES	Head in midline position, avoidance of tight cervical collars and tight circumferential ETT ties; elevate the head of the bed to 30 degrees. (Consider reverse Trendelenburg)

MONITORING & LABS	GENERAL INDICATIONS*	
SEDATION	Propofol 1st choice up to 72°. Other short-acting agents (Fentanyl, Versed) upon discretion of SICU or neurosurgical staff. Typical ICU **Propofol sedation dose range: 20-75 mcg/kg/min**. **Ketamine can also be considered if the patient is hypotensive** or propofol is causing significant hypotension. **Ketamine infusion dosage ranges are from 20mcg/kg/min up to 100mcg/kg/min with 2mg/kg boluses for ICP spikes.**	
TEMPERATURE	Aggressive temperature management. Consider cooling measures (Tylenol, cooling blanket) even for modest temperature elevations (>98.6° F).	
INTRACRANIAL DYNAMICS	▪ Treat sustained ICP elevations >22 ▪ Treat sustained PbtO2 readings < 20 ▪ Always consider an expanding mass lesion with ICP elevations refractory to therapy or NPi decreasing less than 3.0.	
TREATMENT PARADIGM FOR THE TRAUMATIC BRAIN INJURY PATIENT*[(75)]		
ICP Elevated Brain Not Hypoxic **ICP >22mmHg** **PbtO2 > 20mmHg**	Tier 1	▪ Maintain CPP 60-70mmHg. ▪ Increase analgesia to lower ICP. ▪ Increase sedation to lower ICP. ▪ Maintain $PaCO_2$ at the lower end of normal (35-38 mmHg) ▪ Hypertonic saline by intermittent bolus ▪ CSF Drainage by EVD
	Tier 2	▪ Neuromuscular paralysis ▪ Perform MAP Challenge to assess cerebral autoregulation if autoregulation is intact. ▪ Raise CPP by fluid boluses, vasopressors, or inotropes. ▪ Ketamine bolus of 2ml/kg
	Tier 3	Consider secondary decompressive craniectomy
ICP Normal Brain Hypoxic **ICP < 22mmHg** **PbtO2 < 20mmHg**	Tier 1	▪ Increase FiO2 to 100% for 10 minutes to ensure the monitor is working and the PbtO2 improves. If the monitor is working proceed with further steps. ▪ Maintain CPP 60-70mmHg. ▪ Increase CPP to a maximum of 70mmHg with fluids, vasopressors, and inotropes. ▪ Maintain $PaCO_2$ > 35mmHg. ▪ If $PaCO_2$ is already in target range increase PaO2 to 60mmHg
	Tier 2	▪ Ventilator management to increase PaO2 as high as 150mmHg. ▪ Decrease ICP to less than 20mmHg. ▪ Consider CSF drainage ▪ Increase sedation to improve mechanical ventilation. ▪ Neuromuscular paralysis ▪ Perform MAP challenge to assess if cerebral autoregulation is intact. ▪ If cerebral autoregulation is intact, raise CPP to increase $PbtO_2$. ▪ Maintain ICP greater than 70mmHg with vasopressors, inotropes, fluid boluses
	Tier 3	▪ Increase $PaCO_2$ to 45-50mmHg (avoid intracranial hypertension) ▪ Consider normobaric hyperoxia to a PaO_2 above 150mmHg. ▪ If PbtO2 remains < 20 with CPP/MAP optimization, consider transfusing 1 Unit PRBC's if Hgb < 9g/L
ICP Elevated Brain Hypoxic **ICP > 22mmHg** **PbtO2 < 20mmHg**	Tier 1	▪ Maintain CPP 60-70mmHg. ▪ Increase CPP to a maximum of 70mmHg with fluid vasopressor, inotropes. ▪ Increase analgesia ▪ Increase sedation ▪ Maintain $PaCO_2$ > 35mmHg. ▪ Hypertonic saline by intermittent bolus ▪ CSF drainage ▪ If PaO_2 already in the desired range further increase PaO_2 by increasing $PaCO_2$ to 60mmHg

MONITORING & LABS	GENERAL INDICATIONS*	
	Tier 2	▪ Ventilator Management to increase PaO2 as high as 150mmHg. ▪ Neuromuscular Paralysis ▪ Perform MAP Challenge and if cerebral autoregulation is intact increase CPP to 70mmHg with vasopressors, fluid boluses, or inotropes.
	Tier 3	▪ Consider secondary decompressive hemicraniectomy. ▪ Consider normobaric hyperoxia to a PaO2 above 150mmHg. ▪ Consider transfusion of 1U PRBC's if Hgb < 9g/L and CPP/MAP and PaO2 are optimized.

ACUTE CLINICAL DETERIORATION
(e.g., Acute mental status change, blown pupil or other obvious signs of cerebral herniation, new focal neurological symptoms, progressive and refractory ICP elevation)*

1. Verify oxygenation and ventilation	**UNCAL HERNIATION SYNDROME** ▪ Unilaterally dilating pupil ▪ Progression to fixed and dilated. ▪ Progressive impairment of consciousness → comatose ▪ Contralateral Babinski → contralateral weakness → bilateral decerebrate rigidity
2. Hyperventilate ($PaCO_2$ 30-35 mmHg) to temporize only not longer than 15 minutes	
3. Re-dose osmotic agent	
4. Call Neurosurgery	
5. Arrange for emergent CT scan	

GLASGOW COMA SCORE	EYE OPENING	BEST VERBAL EFFORT	BEST MOTOR EFFORT
1	None	None	Flaccid
2	To Pain	Nonspecific sounds	Decerebrates to pain
3	To verbal stimuli	Inappropriate words	Decorticates to pain
4	Spontaneous	Confused	Withdraws to pain
5	-	Oriented	Localizes to pain
6	-	-	Follows commands

COMMON SODIUM DISORDERS SEEN IN HEAD TRAUMA (Discuss therapy with staff prior to initiation.)

Disorder	Na+	Diagnostic clues	Treatment
SIADH	↓	Low SOsm, usually euvolemic, ↑ Uosm Low serum Uric acid level	Free water restriction, hypertonic saline if severe
Cerebral salt wasting	↓	SOsm may be nl, ↑ uop, signs of volume depletion & hemoconcentration, very high UNa Normal serum uric acid level	Volume replacement with NS or hypertonic saline. Oral sodium. Beware of rapid Na+ correction.
Mannitol use	↑	Polyuria, ↑ [Na^+] & SOsm	Hold Mannitol if SOsm > 329 mOsm / [Na+] > 159
Diabetes Insipidus	↑	Polyuria (>250cc/hr), ↑ [Na^+] & SOsm, USpGr <1.005	DDAVP 2-4 mcg SQ/IV BID as permitted by staff neurosurgeon

APPENDIX B: HYPERTONIC SALINE PROTOCOL

Hypertonic (3% saline) may be delivered via peripheral IV or intraosseous access.

1. Give 250cc 3% sodium chloride (NaCl) bolus IV (children 5 cc/kg) over 10–15 minutes.
2. Follow bolus with infusion of 3% NaCl at 50 cc/hour.
3. If awaiting transport; check serum Na+ levels every hour:
   - If Na < 150 mEq/L re-bolus 150 cc over 1 hour then resume previous rate
   - If Na 150–154, increase NaCl infusion 10 cc/hour.
   - If Na 155–160, continue infusion at current rate.
   - If Na >160, hold infusion, recheck in 1 hour.
4. Once Na is within the range- continue to follow the serum Na+ level every 6 hours
5. After cessation of 3% NaCl infusion, and there is no further concern for cerebral edema the Na Levels should be lowered gradually back to the normal range. Recommend decreasing Na by 5mEq/L each day until normal and continuing to monitor at regular intervals for 24hrs after cessation of hypertonic saline.
6. A 30cc Bolus of 23.4% NaCl can also be given over 10-15 minutes. Can be given as IV piggyback or as an IV push over 10-15 minutes by an experienced provider.

APPENDIX C: CLINICAL USE OF PUPILLOMETRY

PURPOSE

To provide guidelines for the use of automated pupillometer in critical care patients with intracranial injuries. This guideline incorporates recent literature defining threshold parameters of normal versus abnormal in order to clarify when nursing staff should contact the primary team for re-evaluation. These guidelines are not a substitute for clinical judgment, but rather an approved multidisciplinary approach to optimize this clinical tool to identify neurologic worsening early while avoiding unnecessary alarms for the primary team.

This guideline applies to all patients for whom there is an intracranial neurologic injury with risk of decompensation per primary team.

BACKGROUND

The pupillary light reflex (PLR) has long been a clinical sign used to prognosticate and monitor brain injured patients. This neuronal circuit transverses the mid-brain and localizes to optic nerve, and oculomotor nerve and also receives blood supply from both anterior and posterior circulation[1]. Thus, there is interest in using this circuit to both monitor for early brainstem compression from mass lesions,[2] and also to identify alterations in circulation from processes such as delayed cerebral ischemia post subarachnoid hemorrhage[3] or increased intracranial pressure[4,5]. A basic neurologic examination includes evaluating the PLR and reporting size and reactivity, however these measurements are very subjective and suffer from poor inter-rater reliability[6,7]. With the advent of automated pupillometry, objective measures of the PLR can be reliably obtained with very high inter-rater and inter-device reliability[8] in civilian[9] and military[10] populations.

Beyond pupil size and reactivity, multiple metrics (pupil minimum / maximum size, percentage change of pupil, latency, constriction velocity, maximum constriction velocity, dilatation velocity) can be gathered and compared to normative standards. A commonly employed device is the NPi-200 Pupillometer, manufactured by NeuroOptics (Laguna Hills, CA). This device, in addition to gathering the above data, compares the gathered data to established normal values to create a Neurologic Pupillary Index (NPi) score which ranges from 0-5. NPi values < 3.0 reflect an abnormal PLR[5]. The presence of a decreased constriction velocity (CV < 0.8 mm/s) is also strongly correlated (but independent) to an abnormal NPi as well as independently associated with elevated intracranial pressure[11]. Developing an understanding of NPi and CV may provide early insight to neurologic deterioration[12].

Because of the rather large anatomic localization of the PLR and the ability to monitor the reactivity of this network reliably and accurately, it has been hypothesized that PLR can be used clinically to follow patients at risk for neurologic decline as a component to a regular neurologic examination. NPi values have been correlated with intracranial pressure as well as mass lesions with brainstem / cranial nerve compression[2,11]. However, more importantly, there is now evidence that changes in the NPi preempts clinical decline.

- In a case series of patients with transtentorial herniation, PLR changes preceded neurologic deterioration by more than 7 hours in half of the subjects[13].
- In a cohort of 56 patients who were admitted to Neurologic Intensive Care Unit with subarachnoid hemorrhage, 7 of 12 patients who developed delayed cerebral ischemia had NPi changes with 71.4% of these changes occurring 8 hours prior to clinical deterioration[3].
- In a cohort of 134 patients who had intracranial pressure monitoring and were evaluated with serial pupillometry, those subjects with abnormal NPi (< 3.0) had significantly higher peak ICPs (19.6 vs 30.5 mmHg). On average, the transition to an abnormal NPi occurred 15.9 hours prior to peak ICP[5].

RECOMMENDATIONS

1. For all patients at risk for neurologic decline from progression of intracranial lesion (traumatic brain injury, intracranial hemorrhage, intracranial mass lesions, vasospasm, hydrocephalus, etc.) pupillometry should be included and recorded with scheduled nursing neurologic examination.

2. If patient's pupillometry values meet any one of the below criteria, the neurosurgeon should be called to evaluate:
   a. NPi drops from > 3 to < 3.
   b. NPi decreases from previous exam > 1.0.
   c. A new difference in NPi (left eye vs right eye) is >1.0.
3. If above thresholds met, then evaluation should include:
   a. Review of vitals, inputs/outputs, current medications/drips
   b. Repeat full neurologic examination (GCS, cranial nerves, language, visual fields, motor exam).
   c. Contact Neurosurgeon on call.
   d. If deemed appropriate by the Surgical Trauma Intensive Care Unit and Neurosurgery repeat CT head (discussion with Neurosurgery if CTA of head and/or neck also indicated).
   e. Review and readdresses goals of neuroprotective measures (intracranial pressure, cerebral perfusion pressure, temperature, serum sodium, etc.).

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APPENDIX D: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Telemedicine Guidance in the Deployed Setting

This CPG is intended to be used as a guide to educate users in the deployed environment about the benefits and limitations of telemedicine.

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Telemedicine Options

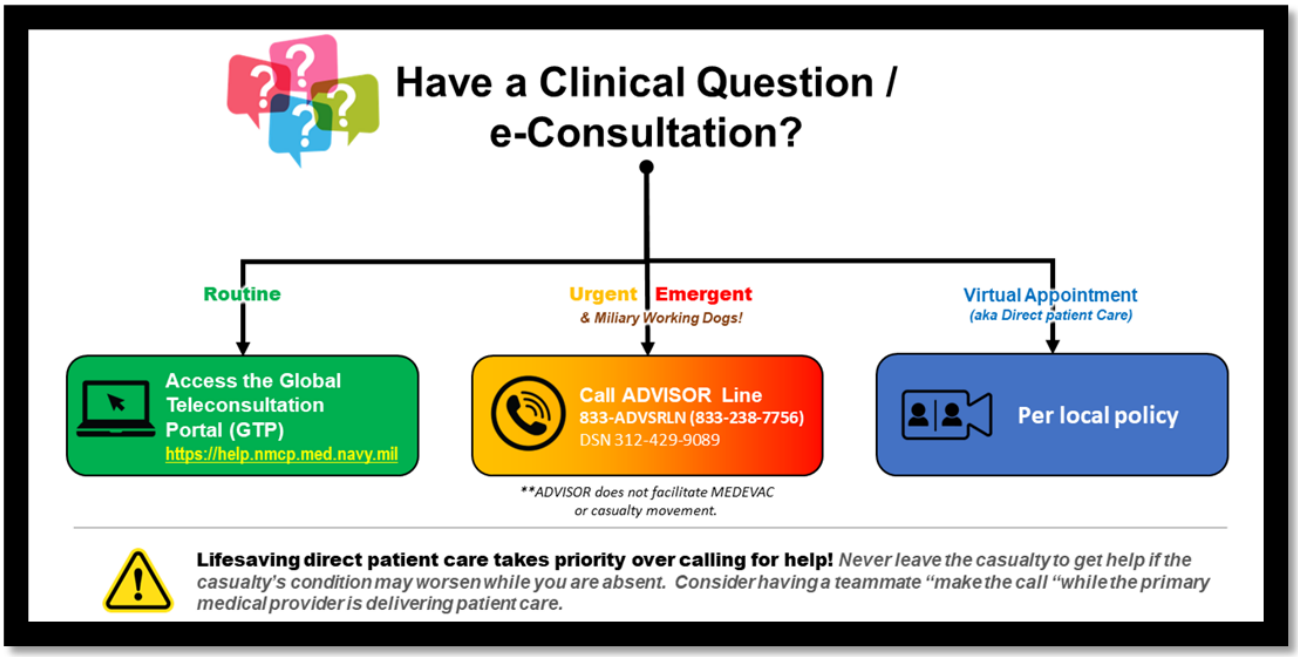

Have a Clinical Question / e-Consultation?
Routine
Urgent Emergent
& Miliary Working Dogs!
Virtual Appointment
(aka Direct patient Care)
Access the Global Teleconsultation Portal (GTP)
https://help.nmcp.med.navy.mil
Call ADVISOR Line
833-ADVSRLN (833-238-7756)
DSN 312-429-9089
Per local policy
**ADVISOR does not facilitate MEDEVAC or casualty movement.
Lifesaving direct patient care takes priority over calling for help! Never leave the casualty to get help if the casualty's condition may worsen while you are absent. Consider having a teammate "make the call "while the primary medical provider is delivering patient care.

Illustration by Raymond Samonte

Teleconsultation has been demonstrated to enhance care quality, reduce lost duty time, optimize evacuation decisions, reduce evacuation costs, and improve casualty outcome.

PURPOSE

This Teleconsultation (TC) clinical practice guideline (CPG) is intended for use by deployed U.S. healthcare providers who are working in contingency settings outside of established Military Treatment Facilities (MTFs) and includes care of Military Working Dogs (MWDs). TC is a subset of Telemedicine (TM) or Virtual Health (VH). TM and VH are synonymous terms that refer to the overall delivery of healthcare using communications technology, usually directly to a patient with video visits. In contrast, local caregivers (LCs) who need guidance to best manage a casualty with available resources and within operational constraints use TC (sometime referred to as an eConsult) to obtain it from remote experts (REs) not physically present with the casualty. Care teams may use a variety of communications technologies to conduct TC including asynchronous solutions like text messaging, email, and web portals and synchronous solutions like chat, phone calls, and video teleconferencing. Importantly, any TM, including TC, is governed by U.S. privacy laws, including the Health Insurance Portability and Accountability Act (HIPAA).

Operational virtual health (OVH), which supports TC for deployed providers, is a collection of solutions (versus a single integrated technology platform) that have evolved over time and require specific

knowledge, skills, and abilities (KSAs) for most efficient and effective use. This CPG provides this information and will be updated as the OVH system continues to evolve.

This guideline focuses on TC instead of TM because most casualties are managed by a deployed medical provider or buddy aid and, given current OVH solutions, it is more consistently available in operational settings. It is a guideline and is not intended to define a standard of care. Every deployed healthcare professional (HCP) and/or local caregiver (LC) making use of this guideline is responsible for evaluating the appropriateness of applying it in the settings of any context.

When available and used appropriately, TC is a critical enabler of better casualty care. It has been demonstrated to enhance care quality, reduce lost duty time, optimize evacuation decisions, reduce evacuation costs, and improve casualty outcome[1-6] but it is NOT a substitution for the deployment of necessary medical support, resources, and evacuation capabilities.

If you are a clinician expert and wish to provide TC as a RE, please contact the OVH Program Manager at the Virtual Medical Center (VMC) by sending an email from a DoD user account to dod.advisor-office@health.mil. ADVISOR is ADvanced VIrtual Support for OpeRational Forces.

BACKGROUND

The U.S. Military has been testing telemedicine solutions for nearly 30 years.[7] It was not until 2017, however, that telemedicine was recognized as an operational requirement by the Special Operations community.[8] Although Joint- and Service-specific requirements for telemedicine remain undefined, it is clear from experience and research that OVH can enhance management of complex casualties in austere and operational environments.[3,6,9-11]

Importantly, OVH provides clinical expertise to the point of need. When caregivers managing casualties reach the limit of their KSAs, two options exist for ensuring a patient receives optimal care: evacuate or call for help. Calling for help has been identified as best practice when it is uncertain if a casualty needs evacuation or when evacuation is not possible. Using TC alters evacuation plans of local caregivers in more than half of cases[2,3,12] and saves the U.S. Military millions of dollars annually. More importantly, these consultations have improved the care provided to casualties while simultaneously enhancing the LC's KSAs through education during the consultation and the RE's through increased understanding of austere and operational contexts.[9]

TC's major limitation is that it requires network resources; if the network is not available, then it is not possible to conduct TC. Still many misperceptions about this limitation exist that need to be dispelled:

- TC is widely accessible and used daily in all environments without specialized communications equipment. It uses available technology: cellular, radio, satellite phone or computer via voice, text, email, internet web portals. Encryption may enhance security or protect patient information but is not a requirement for most medical applications (see below).[13]
- Synchronous voice using radio or phone call is sufficient for most consultations. Voice calls plus asynchronous file transfer (i.e. images) is a highly flexible and adaptable solution for delivering consultation in very austere locations.[14-15] Video TC is most beneficial when LCs require tele-mentoring assistance by a RE to complete a procedure (e.g., fasciotomy, external fixation).[16-17]
- TC is a skill set and a tool that requires training, practice, and a PACE plan (Primary, Alternate, Contingent and Emergent). A team training in TC is able to adapt to conditions on the ground and optimize care for their patient. Last TC use when recorded sets the stage for future

technologies like artificial intelligence and machine learning to produce decision support solutions that do not require network resources.

- Lastly TC takes more time than you think. Conveying information to a RE about the patient to ensure the RE has a clear understanding of the casualty's problems and the clinical questions the LC needs answered are not always straight forward. The efficiency of TC may be improved by following the best practices outlined in this CPG.

Many clinicians fear TC because of concerns about a RE who may be unfamiliar with local context may be critical of care rendered in the operational setting. While this is a valid concern, it has not born out in case reviews and after-action reports. Feedback collected from real-world and training calls about LC experience with REs has been overwhelmingly positive.[3] Remote military experts understand operational constraints and try hard to provide consultation in context to LCs who are often faced with nearly impossible challenges to overcome.

OPERATIONAL TELECONSULTATION BEST PRACTICES

Prepare - Plan and Train

Operational TC begins with the PREP mnemonic: Prepare through Planning and Training; recognize when to "make the call," execute the consultation, and problem solve challenges. Ultimately, the safety and quality of care is the responsibility of the local caregiver and therefore telemedical support in the area of engagement (AOE) requires preparation and a PACE (Primary, Alternate, Contingency, and Emergency) plan to be successful. If a local caregiver intends to have consultation available but is unable to reach a remote consultant through one communications method, alternate methods should already have been established and tested. Thus, PACE planning takes two forms, one about when to utilize telemedicine and one for how to use telemedicine. See example in Table 1. A detailed example is in Appendix A.

Table 1. PACE Planning.

Examples provided of general AOE conceptual care plan and telemedical technology plan.
Note: the telemedicine technology PACE plan supports the alternate and contingency patient care plans. Consider the power, network, and equipment items below to be independent plans that could be "mixed-and-matched" according to need and functioning. Thus, the primary power plan could support the alternate network and contingency equipment. The technology plan should build from most reliable to least reliable.

PACE Planning		
	Patient care plan	**Telemedicine Technology**
Primary	Use local assets; evacuate the patient; pre-position resources (i.e. if you expect to need a surgeon, have an OR and a surgeon available).	Power: electrical grid Network: fiber or cable internet Equipment: Dedicated telemedicine equipment (i.e. VTC exam station, camera, augmented reality device)
Alternate	Use established telemedicine relationship to support care-in-place or during evacuation	Power: solar cell battery network: 4G/LTE cellular network Equipment: cell phone/tablet +/- peripheral exam equipment
Contingency	Use ad hoc telemedicine relationships (i.e. "phone-a-friend") to support care-in-place or during evacuation	Power: gasoline generator Network: Satellite Equipment: laptop/desktop computer, digital camera, e-mail
Emergency	Use un-approved, non-standard local solutions (i.e. local economy, high-risk care by untrained individual) to achieve "best-possible" outcome	Power: batteries Network: telephone, radio Equipment: phone, radio

Once a plan exists for when and how to perform TC, medical teams must train in realistic scenarios that require TC use to ensure this capability is available and easily utilized when needed. Given a variety of constraints in time, Class VIII (medical material equipment, consumables, blood), funding, and personnel, most medical training focuses on managing common casualties in typical operating contexts. These scenarios rarely require LCs to engage in TC because the scenarios do not outstrip their level of training or resource availability. TC, in its current form, is an ALTERNATE care plan for prolonged casualty care (PCC) or unusual cases that exceed PRIMARY plans. Therefore, training must include unexpected scenarios that require KSAs that are unavailable to the trainees and cannot be reasonably obtained by them prior to a deployment or within their scope of practice, and thus require them to call for help from a RE. Examples include:

- Medics/corpsmen managing a burn patient over time, especially if needs include an escharotomy and advanced airway management.
- Role 1 providers managing severe community acquired pneumonia that requires mechanical ventilation or a patient with an extremity injury that requires fasciotomy.
- Role 2 surgical team managing a casualty with a head injury that requires neurosurgical input and a decompressive craniectomy or a septic patient that develops the acute respiratory distress syndrome.
- Role 3 team managing a local national with an infection caused by a highly drug resistant organism, or a patient with acute kidney injury that requires renal replacement therapy, or a burn patient with severe inhalation injury.

RECOGNIZE

Culturally, the U.S. Military trains medical providers to succeed on their own merits; we validate individuals, not their ability to perform tasks or manage casualties as teams. Consequently, one of the hardest aspects of TC is for LCs to recognize when they should call for help. When a healthcare provider is uncertain about a casualty's diagnosis or the best management plan, s/he should consider calling for help. Because there is no single-entry point for TC within the OVH system, LCs must first determine the urgency of the consultation and then conduct TC using the appropriate technology. The OVH system is divided into routine TC and urgent/emergent TC, and direct patient care. Table 2 on the next page highlights these TC pathways and when LCs should use one or the other.

Table 2. The operational virtual health system according to teleconsultation acuity and direct-to-patient telemedicine.

<table>
<tr><th>Routine</th><th>Urgent</th><th>Emergent</th><th>Direct Patient Care</th></tr>
<tr><td rowspan="2">Asynchronous* Support using Portals
Global Teleconsultation Portal (GTP)
https://help.nmcp.med.navy.mil

Asynchronous TC may be converted to synchronous TC (voice or video) depending on need and availability</td><td colspan="2">Synchronous Voice through ADVISOR+
833-ADVSRLN (833-238-7756)
DSN 312-429-9089</td><td rowspan="2">**Not Described by this CPG**
Synchronous (voice/video) Virtual Health Appointments

Available only for

Tele-Behavioral Health
Through embedded behavioral health providers
&
LRMC Catchment Area
DSN: 314-590-4600
Commercial: +49 (0) 6371 9464 4600</td></tr>
<tr><td>Specialty Support for:
General/Trauma Surgery
Orthopedic Surgery
Pediatrics
Infectious Disease
Toxicology
Hematology/Oncology
Obstetrics/Gynecology
Dental</td><td>Critical Care
Chemical Casualty Care
Burn Center
Toxicology
Veterinary Medicine-Military Working Dog
Ophthalmology
Neonatology
Emergency Department and subsequently any Specialty Not Listed#</td></tr>
<tr><td colspan="3">* Audio only TC may be converted to video or asynchronous text/email depending on need and availability</td></tr>
<tr><td>Routine Consults require a consultant response within 24 hours. Routine patients have NORMAL vital signs and are not at risk for deterioration within the next 24 hours. The consultant and casualty have time to wait for a response.
Some mission requirements demand more immediate medical decisions due to short communications “windows” or operational context. Limitations due to time should encourage local caregiver to use urgent consultation systems (see above).
To use GTP), you must have a username and password.
To obtain a username/ password go to:
https://help.nmcp.med.navy.mil/path/user/ViewLogin.action</td><td>Urgent consults are all cases not routine or emergent or any questions you have about non-life-threatening conditions that require specialty medical advice and would benefit for synchronous communication between the local caregiver and the remote consultant. A good example of an urgent consult might be complex wound management.
Calls for ADVISOR Specialties not listed will be routed to the Role 4 ED within the line of evacuation to assist with connection to that specialty on call in the medical center.
**Importantly – ADVISOR is NOT a route of MEDEVAC and does not facilitate casualty movement or patient handoff.
Virtual Medical Center CAC link:
https://info.health.mil/army/VMC/Pages/OpsMed/Operational-Medicine.asp x</td><td>Emergent consults are for casualties with critical illness/injury. The following are some indicators:
Shock (e.g. shock index greater than 1 [HR/SBP > 1])
Respiratory failure
Severe infection/sepsis
Severe electrolyte abnormalities
Encephalopathy (altered mental status)
Severe TBI /elevated intracranial pressure (e.g., head injury with depressed level of consciousness)
Abnormal vital signs lasting > 30 min, or rapidly worsening, or other concerns:
HR < 30 or HR > 110;
SBP < 90 or SBP > 200;
RR > 30;
O2 Sat < 88%;
Urine output < 0.5cc/kg/hr for > 2 hr; Complex/hemodynamically significant arrhythmias
Poisonings/toxicology emergencies
Chemical Casualty Care
Any medical emergencies, life threatening conditions, organ failure (e.g., myocardial infarction, stroke, renal failure, liver failure, severe anemia/thrombocytopenia, etc.)</td><td>Mental health can be a challenging problem during deployment. TBH may be beneficial, however it must be established by trained individuals and through appropriate channels. Follow unit SOP or contact _____ to determine if TBH is available for your deployment medical plan.
Units within EUCOM and or adjacent AORs may be able to take advantage of LRMC virtual support and video visits. For routine outpatient problems, call the above to obtain appointment times and instructions.
These vital signs triggers are only recommendations. Providers should initiate TC whenever they feel a patient’s condition requires it

CAC enabled site:
https://info.health.mil/army/VMC/Pages/OpsMed/Operational-Virtual-Health-in-the-European-Theatre.aspx</td></tr>
<tr><td colspan="4">+ Although the ADVISOR program was originally designed for operational VH support, it may also be utilized in garrison for2. Due to COVID-19 garrison to consult: Critical Care at n-JTCCN MTFs, Infectious Disease (adult/pediatric), Palliative Care. The caller must identify that they are requesting support for patients located in a garrison MTF.</td></tr>
</table>

Global Teleconsultation Portal (GTP) is a Defense Health Agency (DHA) supported low-bandwidth web-based, secure, HIPAA-compliant, asynchronous platform used for non-urgent provider-to-provider teleconsultation, patient movement, and case management. Operational providers and consultants can access GTP and request a new account at: https://help.nmcp.med.navy.mil/path/user/Login.jsp

Lifesaving direct patient care takes priority over calling for help! Never leave the casualty to get help if the casualty's condition may worsen while you are absent. Consider having a teammate "make the call "while the primary medical provider is delivering patient care.

EXECUTE

The hardest and most dangerous part of TC is for the RE to efficiently provide an accurate consultation when unable to assess a casualty themselves – inaccurate information can lead to bad recommendations and, in the worst case, bad patient outcomes, or, more commonly, confusion. Consequently, the hardest part of TC for the LC is conveying an accurate description of a patient to a RE.

LCs must possess excellent assessment skills and the ability to convey their assessment to a RE efficiently. Inaccurate and/or incomplete assessments poorly communicated to a RE makes TC inefficient because the RE will inevitably pose probing questions of the LC to better understand a casualty's condition, problems, and treatments.

To date, no adverse outcomes associated with military TC have been reported. More commonly, poorly communicated data or incomplete assessment leads to frustration, lengthy consultations, dissatisfaction with recommendations, and ultimately delayed casualty care.

To avoid this, LCs must be prepared for TC. Unfortunately, many caregivers may find conducting a TC to be anxiety provoking because they may be unsure of their assessment, uncertain about what information to provide an RE, and are worried the RE will judge them. Probing RE questions to gain further confidence in data shared may feel uncomfortable for LCs, especially if/when data is missing due to incomplete assessment. THIS IS COMMON: every caregiver has a different way of prioritizing information and not all information will be available at the time of consultation. Real world consultations take an average of three (3) synchronous TC encounters to complete, often with several asynchronous communications between synchronous touch points. Missing data may be filled in over-time and recommendations may be refined or even changed as information is updated.

The following best practice recommendations have been identified to maximize TC efficiency, information transfer, and quality of recommendations while minimizing frustration and risk of missing information necessary for best consultation in context:

1. If calling the ADVISOR line:
    - When the agent answers the phone, tell the agent if the call is real-world and deployed or in garrison or for training.
    - Indicate the specialty needed or, if unknown, ask for the emergency department.
    - Provide a good call-back number.
2. Use a script familiar to the both the local caregiver and remote consultant (see Appendix B for an example with an instruction on use).
3. Send background information using asynchronous technology ahead of synchronous TC encounters (see below).
4. Use closed loop communication that includes intentional pauses in communication for read-back and clarification.

5. Have the RE document the telemedicine encounter and send that documentation with a summary of recommendations to the LC using an agreed upon asynchronous solution.

Images and Asynchronous File Transfer - Best Practices

Sending information, documentation, files, and particularly images (sometime of other files) related to casualty care before synchronous TC is a best practice because it allows the RE to consider the context of the consultation and to begin organizing thoughts ahead of the TC.

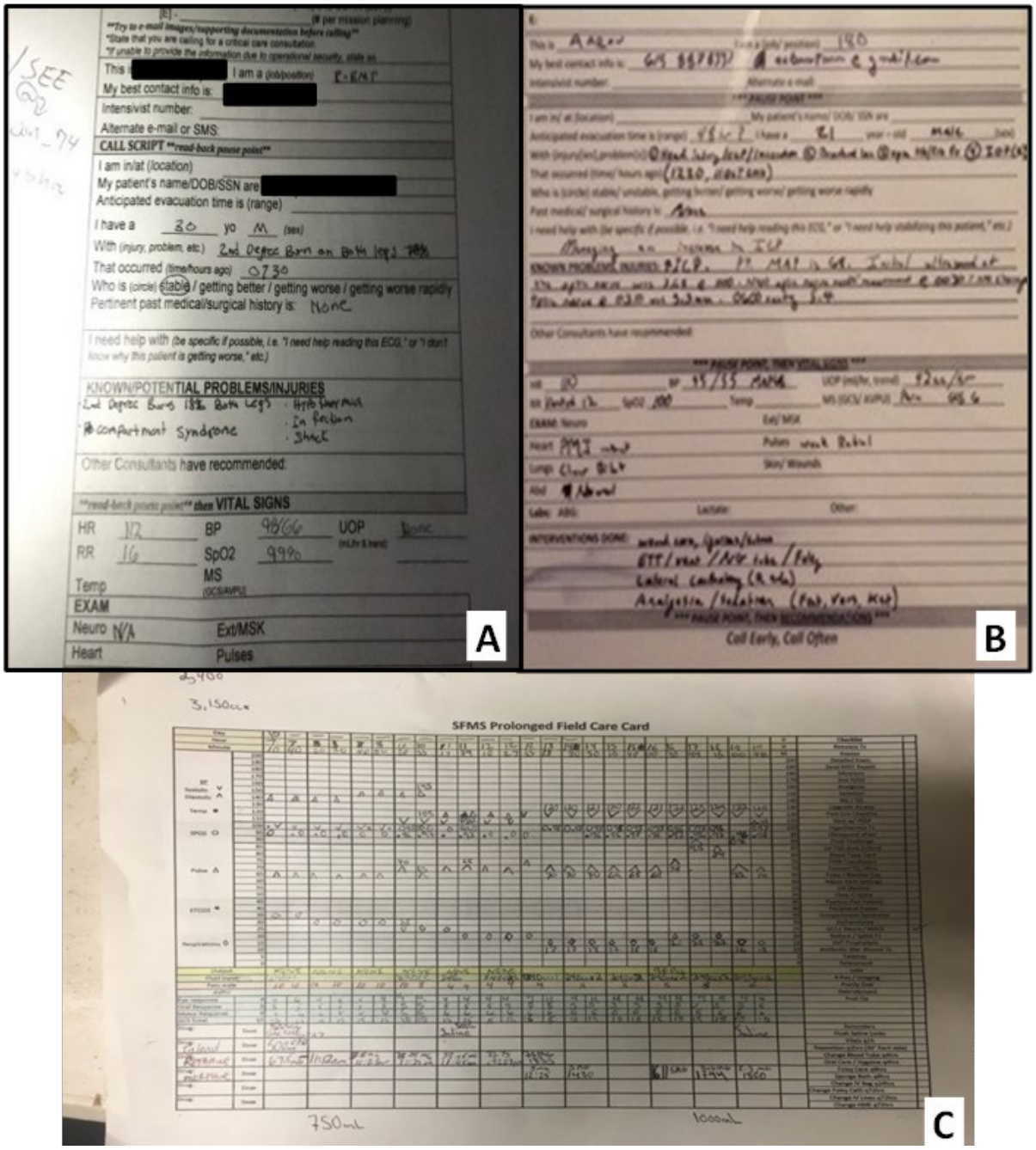
1. Ideally, send images of patients and care context to REs before starting a TC. This helps the remote expert to provide "consultation in context" and avoids recommendations that are discordant with local capabilities. Useful images include:
    - Flowsheet and other documentation like the TC script
    - Patient wounds
    - Imaging – pictures or video of collected imaging studies (ultrasound, x-ray, etc.)
    - Whole patient
    - Special equipment
    - Facility or aid station
2. Image quality is important (Figure 1). Photographs that are less than 500KB are often of insufficient quality to convey information to a remote consultant.
3. Be mindful of patient privacy and operational security (OPSEC):
    - Images should be compliant with HIPAA. Do not include personally identifiable information in the image like full face images and unique tattoos unless they are essential for communicating injury or disease state to the remote expert in which case the image must be encrypted before sending. Best practice is to use the GTP to send these images.
    - Similarly, do not include images of the environment that could cause a safety issue for the local care team by exposing their location or affiliation or other information that could be used against them (consider, for example, media implications of the image).
4. Note that digital photos may also contain "geotags" which can provide an exact location where it was taken. This feature can be disabled if there are security concerns. The easiest way to do so is to disable location services on your device before taking pictures.

Security - Cyber, OPSEC

- DO NOT DELAY teleconsultation due to an unsecure connection unless operational requirements dictate otherwise.
- Traditional teleconsultation is UNCLASSIFIED; the local caregiver should maintain normal rules of operational security when utilizing unclassified networks. Most RE consultants DO NOT have access to SECRET communications, but this may be established in special circumstances after UNCLASSIFIED communication is established first.
- Maintaining patient privacy should be a priority, and many available tools for communication meet patient privacy requirements.
- When sending patient information or images by open communication methods, limit patient identification to gender and age. Location can be generic by addressing temperature (hot/warm/cold), surroundings (urban/rural), or environments (desert/tropical).

- Location to the level of continent or region can be useful for the consultant/expert to better identify diseases specific to certain areas (e.g., hemorrhagic fevers, malaria, etc.).

Figure 1. Telescript examples


I am a (job/position) E-EMT
My best contact info is:
Intensivist number:
Alternate e-mail or SMS:
CALL SCRIPT **read-back pause point**
I am in/at (location)
My patient's name/DOB/SSN are
Anticipated evacuation time is (range)
I have a 30 yo M (sex)
With (injury, problem, etc.) 2nd Degree Burn on Both legs 18%
That occurred (time/hours ago) 0730
Who is (circle) stable / getting better / getting worse / getting worse rapidly
Pertinent past medical/surgical history is: None
I need help with (be specific if possible, i.e. "I need help reading this ECG," or "I don't know why this patient is getting worse," etc.)
KNOWN/POTENTIAL PROBLEMS/INJURIES
2nd Degree Burns 18% Both Legs
Hypothermia
Infection
Shock
Compartment Syndrome
Other Consultants have recommended:
read-back pause point then VITAL SIGNS
HR 112
BP 98/66
UOP None
RR 16
SpO2 99%
Temp
MS (GCS/AVPU)
EXAM
Neuro N/A
Ext/MSK
Heart
Pulses
A
Call Early, Call Often
B
SFMS Prolonged Field Care Card
C

The provided examples in the above figure are examples of call scripts sent ahead of the teleconsultation (TC) with a remote expert (RE). Panel A (size 2.17MB) is larger, takes more time to send, but is of sufficient quality to be read. Panel B (size 36.4kb), transmits easily, but is uninterpretable and of no utility. A reasonable file size that balances transmissibility and legibility is 500-1000kb (0.5-1MB).

Panel C is a great example of legible and functional transmission of a vital sign flow sheet with the interventions sent to the RE prior to the initiation of TC.

PROBLEM SOLVE

A general understanding of the capabilities and limitations of the various TM and TC technologies available is important. Intentionally using different technologies during training, especially switching between them, and limiting network resources during an encounter, helps LCs and REs become flexible in their use of technology and its limitations for delivering casualty care with TC support. ***Not all questions can be answered with TC; sometimes the best recommendation is simply to evacuate the casualty or experience the consequences.*** Still, TC may help mitigate risks if/when evacuation is no possible or available quickly.

Synchronous video helps make TC more efficient because REs can see what is happening in real time, but it is rarely required if TC does not involve tele-mentoring a procedure. Preliminary data from a small study presented in abstract[10] demonstrates that key aspects of procedural quality may suffer when voice only TC is utilized for procedural tele-mentoring compared to video. When not performing a procedure, sending image asynchronously and/or providing detailed description by text or during synchronous audio TC can convey the same information as real-time video with significantly less network consumption. Indeed, some procedures can be completed with frequent asynchronous "chats" that include images (often with the RE sharing annotations on the image).

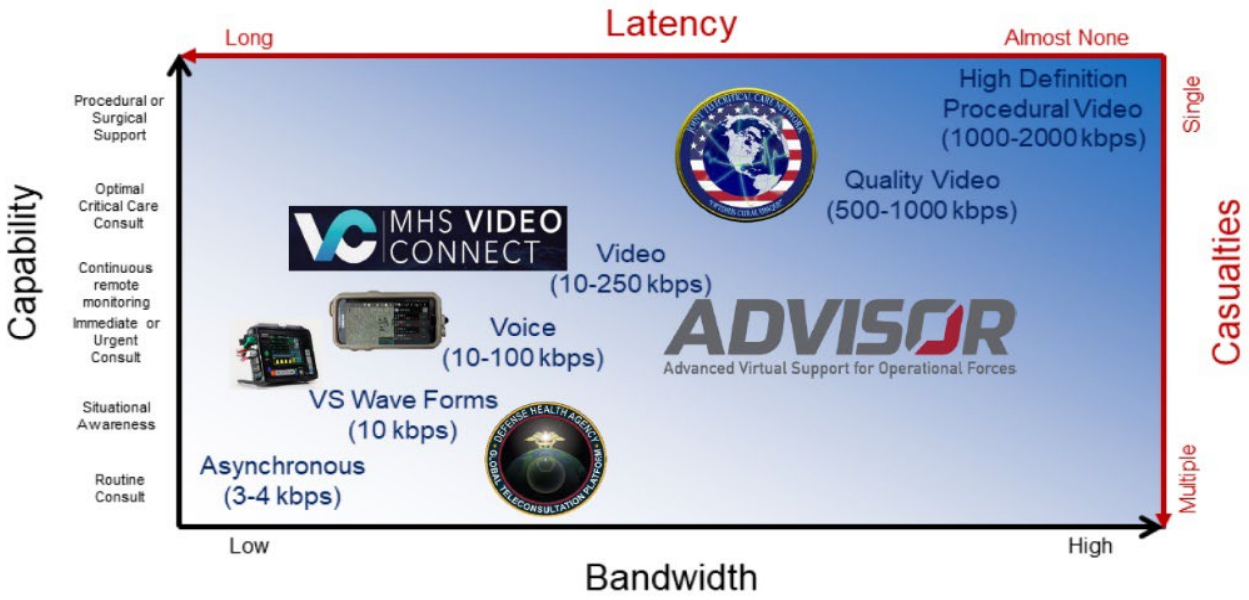
Because the telemedicine capability is a function of network resources matched to the number of casualties or encounters (Figure 2), understanding this relationship is important for mission planning.

Always use the most appropriate technology to optimize the consultation. Do not waste time establishing a network heavy video TC if lesser or more available technology (i.e. a radio or phone call) is sufficient. Also, it may be possible to increase the technology (i.e. go from an asynchronous consultation to a video consultation) if resources (hardware, software, and network) are available and the TC would benefit.

Understand the limitations of your technology and how to maximize its utility. It is difficult to complete a physical exam or part of a physical exam virtually without the correct digital equipment (e.g., stethoscope, ophthalmoscope, otoscope, etc.). Similarly, if bandwidth is limited, but video is needed by the RE for understanding, consider turning off the RE's video (thus decreasing bandwidth needs by approximately half).

If utilizing TC for casualty care, always have a back-up means of communication – a second radio/frequency, a second phone-line/cellphone (on both ends of the encounter – LC and RE), an alternate computer – whatever your pace plan states. At the beginning of an encounter, always ensure that call back numbers and second options are discussed at the beginning of the consultation (this is included in the example call scripts in Appendix B). Train to use back-up options.

Figure 2. Telemedicine capability is a function of network resources, particularly bandwidth and latency, matched to the number of casualties or encounters.



While network resources may be robust and able to support multiple continuous remote monitoring encounters, they may rapidly diminish when supporting a real-time, high quality video teleconference to facilitate a procedure. Similarly, asynchronous modes of communication (texting, email) require little bandwidth making it possible for many local caregivers to consult remote experts simultaneously, but it will take longer to receive responses. Increasingly synchronous and higher quality modes of communication require increased amounts of bandwidth but deliver shorter latent periods and increased capabilities to support local caregiver needs. Increasing network resources increased capability or encounter volume or both.

DOCUMENTATION

Documentation of the TC encounter is important for process improvement and lessons learned as teleconsultation continues to develop and inform future CPG development.

Documentation of casualty care is ultimately the responsibility of the LC providing direct care. All theater and local command documentation requirements should be completed by the LC. Best practice, however, is for REs to also document their consultation and recommendations and to send them to the LC as soon as possible. For routine consultations, this is automatic within the GTP. For TC not utilizing the GTP (urgent/emergent consultation), asynchronous communication between LCs and REs is on an ad hoc basis (using HIPAA compliant messaging applications or using encrypted email).

Additionally, REs document all OVH encounters using the Operational Virtual Health Report (OVHR) available at: https://info.health.mil/army/VMC/Lists/OperationalVirtualHealthReport/Item/newifs.aspx?source=/army/VMC/Pages/VMC/ADVISOR.aspx (must have CAC enabled computer/mobile device).

If a TC is for a casualty who is a Military Health System beneficiary, and at least two of the following patient identifiers are available and can be provided by the LC managing the casualty, REs should document the encounter in MHS Genesis or other electronic medical record:

- Patient name
- Social Security Number
- DoD Identification Number
- Date of Birth

Best practice is to copy information from the OVHR into the appropriate note in the EMR.

TC encounters for patients who are NOT MHS beneficiaries or for whom identifiers are not available/cannot be provided cannot have documentation in the EMR. REs will complete OVHRs and send recommendations to LCs as described above.

LCs utilizing ADVISOR for TC are also asked to complete an Operational Virtual Health Evaluation (OVHE) available at: https://info.health.mil/army/VMC/Lists/OperationalVirtualHealthEvaluation/Item/newifs.aspx?source=/army/VMC/Pages/VMC/ADVISOR.aspx .

When deployed LCs need to follow up with the appropriate medical theatre POCs on where they should document the patient encounter.

SUMMARY & KEY POINTS

While Joint requirements documents for OVH continue to process, military medical providers have increasingly utilized formal and informal OVH capabilities to solve real-world problems. This is a natural evolution of casualty care secondary to continuous improvements in communications technologies, the process of healthcare delivery learnt during medical training, and the specialization and sub-specialization of the medical profession that occurs with the march of scientific discovery in medicine.

This guideline has focused on TC as a tool for increasing LC's KSAs in real-time through care coordination with a RE, effectively increase scope of practice to manage complexities of casualty care created by operational constraints (like delayed evacuation). The CPG highlights the PREP mnemonic as a model for maximizing the benefit of TC and minimizing risks.

The following best practices for TC in resource limited, austere, and operational environments are summarized as follows:

1. **PREPARE:** Telemedicine is a skill that must be practiced by both local caregivers and remote experts to prepare for efficient and effective interactions. Ideally, this care team should train together using simulated patients to optimize their communication and ensure their technology choices match their clinical needs. Utilize PACE planning to harden your TC capabilities (Appendix A).
2. **RECOGNIZE:** Local caregivers must recognize when TC is necessary (i.e. "when to make the call") and what process to use based on the acuity of casualty. Conceptually, the more "acute" a

patient is, the earlier and more frequently the LC should engage with the remote expert. "Call early, call often" is a saying used often by REs when casualties are severely ill or injured. Routine, Urgent, and Emergent TC should be conducted using the resources outlines in Table 2.

3. **EXECUTE:** Effective and efficient teleconsultation takes practice, but can be improved by
   - Using a script familiar to the both the local caregiver and remote consultant (Appendix B).
   - Sending background information using asynchronous technology ahead of synchronous telemedicine encounters.
   - Using closed loop communication that includes intentional pauses in communication for read-back and clarification.
   - Having the remote expert document the telemedicine encounter and sending that documentation with a summary of recommendations to the local caregiver.
4. **PROBLEM SOLVE**: Understand the capabilities and limitations of available TC technologies and what types of TC can be performed using them. Be able and willing to switch between technologies when appropriate and have back-up communications solutions.

https://prolongedfieldcare.org/telemed-resources-for-us-mil/ offers some excellent information about operational TC form an experienced group of clinicians.

Additional information about the GTP and ADVISOR programs can be found at: https://info.health.mil/army/VMC/Pages/Home.aspx or by emailing dod.advisor-office@mail.mil

When utilized effectively, TC can improve casualty care, reduce evacuation costs, and optimize casualty outcomes in many challenging deployment contexts.

When in doubt, call early and call often.

PERFORMANCE IMPROVEMENT

JTS is a performance improvement (PI) organization which employs a systematic approach to determine the acute and long-term outcomes of all casualties, the quality of care, improvements in prevention and treatment and logistical implications. The JTS supports U.S. military PI initiatives by identifying, tracking, and making recommendations on PI measures to ensure the appropriate evaluation and treatment of injured Service members across the continuum of care and improve patient transition between phases of care.

The JTS PI Branch coordinates all PI activities across the spectrum of DoD trauma care and resolves trauma system patient care issues. JTS PI work relies on data collected in the DoD Trauma Registry. The data enables JTS to conduct gap analyses for medical capabilities to direct ongoing and future combat casualty care research, trauma skills training, and direct combat casualty care.

OVH utilizes encounter and summary statistics collected from the GTP, ADVISOR call center, OVHRs, and OVHEs to monitor the "health" of the system. Metrics tracked from these sources include:

- Number of Routine, Urgent, and Emergent TCs
- Location origin by Combatant Command

- Number of missed calls and failed connections
- Time from call to connection with RE (urgent/emergent calls) or time to receive recommendation form RE (routine)
- Quality of LC consultations (quality of presentation, appropriateness of questions, ability to provide appropriate recommendations)
- Quality of RE consultations (quality of the interaction, quality of the recommendations, and ability to implement recommendations
- Casualty outcomes when available
- Evacuations avoided or downgraded
- % of OVHR/OVHE completion

PI MONITORING

POPULATION OF INTEREST

Patients in resource-constrained operational environments requiring teleconsultation using the GTP and ADVISOR platforms.

INTENT (EXPECTED OUTCOMES)

- Local caregivers develop and maintain a teleconsultation PACE plan as part of mission planning.
- Local caregivers utilize call scripts when communicating with remote experts on ADVISOR.
- ADVISOR remote experts forward written guidance to local caregivers as a supplement to verbal advice.
- Teleconsultation details are documented with the encounter in the patient's health record. Details include consultant's name, specialty, and recommendations.
- Local caregivers submit an Operational Virtual Report Evaluation when using ADVISOR.
- Remote experts submit an Operational Virtual Health Report when using ADVISOR.

DATA SOURCES

OVH utilizes encounter and summary statistics collected from the GTP, ADVISOR call center, OVHRs, and OVHEs to monitor the "health" of the system.

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for CPG compliance. The system review and data analysis are performed by the OVH program.

RESPONSIBILITIES

The OVH program manager and deployed unit is responsible to ensure familiarity, appropriate compliance, and PI monitoring with this CPG.

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APPENDIX A: PACE PLANNING FOR TELEMEDICINE

The below tables provide examples and considerations for developing your teleconsultation PACE plan.

Table 1. The patient care and teleconsultation plan will depend on mission analysis.

	Patient Care Plan
Primary: Normal operations	Patient care and evacuation according to doctrine, roles of care, evacuation. If uncertain about the need for evacuation of a routine casualty, and unable to determine this using local resources (e.g. battalion surgeon, regional support medic, etc.), engage the TC routine or urgent system. If a casualty evacuation is delayed beyond planning purposes outstrips LC KSAs +/- local supplies or resources. ENGAGE TC urgent or emergent system through communications plan.
Alternate: Failed communication to one planned expert	If unable to contact the preferred TC solutions, use alternate solution. ▪ If unable to contact the GTP for a routine TC case, call the ADVISOR line. ▪ If unable to contact the ADVISOR line for an urgent/emergent TC case, send message through the GTP.
Contingency: Unable to use established TC solutions	Use ad hoc telemedicine relationships (i.e. "phone-a-friend") to support care-in-place or during evacuation. This could take the form of a phone call, radio transmission, or email. Identify these individuals and contact method beforehand. Consider use of internet-based information to help manage casualty.
Emergency: No network or communications so no TC available	Use un-approved, non-standard local solutions (i.e. local economy, high-risk care by untrained individual) to achieve "best-possible" outcome. Identify hospitals and medical assets in the local area of operation and their contact information. Consider establishing relationships early. Identify manuals, textbooks, how-to-guides for when/if there is no internet and no communications.

Table 2. Telecommunications Technology Plan will depend on mission analysis.

	Technology Plan
Primary	**To Local Support:** Radio per SOP. **To DoD OVH systems:** ▪ **Power**: Electrical grid ▪ **Network**: Fiber or Cable internet ▪ **Equipment**: Dedicated telemedicine equipment (i.e. VTC exam station, room camera, augmented reality device, peripheral devices)
Alternate	**To Local Support:** Operational Chat **To DoD OVH systems:** ▪ **Power**: Solar Cell Battery ▪ **Network**: 4G/LTE Cellular Network ▪ **Equipment**: Mobile Phone/Tablet +/- peripheral exam equipment
Contingency	**To DoD OVH systems:** ▪ **Power**: Gasoline generator ▪ **Network**: Satellite ▪ **Equipment**: Laptop/desktop computer, digital camera, e-mail
Emergency	**To DoD OVH systems:** ▪ **Power**: Batteries ▪ **Network**: Telephone, radio ▪ **Equipment**: Phone, radio

APPENDIX B: VIRTUAL CRITICAL CARE CONSULTATION (VC3) GUIDE

VIRTUAL CRITICAL CARE CONSULTATION (VC3) GUIDE – 2 2017 (v3.1)
To be used with Prolonged Field Care Card

1. Before calling, email image of the casualty (wounds, environment, etc.), "capabilities" (back of page), & vital signs trends:

Critical Care - Dod.criticalcare@health.mil or Dod.vc3@health.mil General/Trauma Surgery - Usarmy.dod.advisor.surgery@health.mil
Orthopedic Surgery - Usarmy.dod.advisor.ortho@health.mil Toxicology - Usarmy.dod.advisor.tox@health.mil
Infectious Disease - Usarmy.dod.advisor.id@health.mil Hematology/Oncology - Usarmy.dod.advisor.hemonc
OB/GYN - Usarmy.dod.advisor.obgyn@health.mil Vet-Europe - Usarmy.dod.advisor.veteurope@health
Vet-Pacific - Usarmy.dod.advisor.vetpacific@health.m

2. If call not answered: a) call next number on PACE or call back in 5 – 10 min.
3. If unable to provide information due to operational security, state so.

This is _____ I am a (job/ position) _____
My best contact info is: _____
YOUR best contact info is (Consultant's number): _____Alternate e-mail: _____

*** PAUSE POINT *** ***CONFIRM CONTACT INFO***

I have ____ (number) of casualties to discuss with you.
The ___ (1st, 2nd, 3rd,…) is a __ year–old ____(gender) _____ (active duty/foreign national/OGA,etc.), who has the following:

Mechanism of Injury or known diagnosis(es) that occurred in (location)
The injury/start of care occurred *hours ago*. Anticipated *evacuation time* is (range)
Injuries/Problems/**S**ymptoms:

Treatments:

He/she is currently (circle) stable/ unstable, getting better/ getting worse/ getting worse rapidly
Known Medication Allergies/Past medical/Surgical history is:

I need help with (*be specific if possible, i.e. "I need help reading this ECG," or "I need help stabilizing this etc.)*

Other Consultants have recommended:

*** PAUSE POINT *** ***Remote Consultant to ask clarification questions*** ***

VITALS (*current* & *trend* as of): HR BP RR SpO2 $EtCO_2$ Temp
UOP(ml/hr) over (# hours) Mental Status (GCS/ AVPU)
EXAM: Neuro Ext/ MSK
Heart Pulses
Lungs Skin/ Wounds
Abd
LABS: ABG: Lactate: Other:

*** PAUSE POINT *** ***Remote Consultant to ask clarification questions*** ***

Don't skip Pause points! Use them to ensure that key information is communicated.

DO NOT Write PII (personally identifiable information) on the call script if you intend to send a digital copy (completed/photograph) via e-mail. Just be prepared to give this information during the call.

Hours since injury/start and anticipated EVAC time:

IMPORTANT
DO NOT USE your time of injury. Consultants are often in different time zones. State the *hours since the injury* occurred or the amount of time you have been caring for the casualty. Give estimate of anticipated time until evacuation.

Patient history: BRIEFLY tell the patient's story using a modified MIST format:
Mechanism of Injury/Illness
Known **I**njuries/Problems
Current **S**ymptoms
Treatments Rendered.
Describe mechanism of injury or history of present illness (when symptoms started, what were they, how they progressed, etc.). List the known problems *explicitly*. Provide assessment of patient stability or clinical trend. Provide any known past medical history/surgical history/allergies.

If you have called other consultants, describe what they have recommended thus far.

Describe what you need the consultant to help you with. Be as specific as possible.

Use these sections to organize notes/ thoughts from the consultant back to you.

Plans/Recommendations

PRIORITY	SYSTEM/PROBLEM	RECOMMENDATION
	Neuro or problem #1	
	CV or problem #2	
	Pulm or problem #3	
	GI or problem #4	
	Renal or problem #5	
	Endocrine or problem #6	
	MSK/ Wound or problem #7	
	Tubes, lines, drains or problem #8	
	Prophylaxis/prevention or prob#9	
	Other	

TO-DO/ FOLLOW-UP/TO-STOP **NOTES**

1.
2.
3.
4.
5.

Perform a READBACK!

**** PAUSE POINT, for Medic/Local Caregiver to ask clarification questio* READBACK***

Use this section to describe what **equipment** you have. Preferably send a picture of this section ahead of the call. If possible, also take a de-identified picture of the **casualty** , an image of the **care environment** (if OPSEC permits), and an image of **flow sheets** ("ECCF" images) to send ahead of the call. **MIMIMUM IMAGE SIZE** is 500 KB for text/flow sheets)

Available "kit" (supplies, equipment, medications) !! IF POSSIBLE PHOTOGRAPH AND SEND VIA EMAIL BEFORE CALLING !!

IV access: IV Central line IO (location) Other:_____

Monitor: Propaq Tempus Foley Graduated urinal PulseOx only Exam Only

Other:_____

Commo: Tempus i2i ID: _____ THIAB:_____ SAT#_____ Local Cell#_____

Web VTC Address_____

Other (e.g. "FaceTime, VSee, Skype, etc.):_____

IV Fluids: Plasma-Lyte LR Normal Saline 3% saline Other:_____

Colloids: Hetastarch Albumin Other:_____

Blood products: Whole blood PRBC Plasma FDP Platelets Other:_____

Medications: Antibiotics: name/route/dose_____

Morphine IV/ PO Other opioid (name/ IV/ PO): _____

Fentanyl IV/ PO (pop) Ketamine

Midazolam Diazepam (IV/ PO)

TXA Other(s): _____

Airway supplies: ETT Cric kit LMA Ventilator BVM O2 Suction

Misc:

APPENDIX C: TECHNOLOGY REQUIREMENTS TO GET STARTED

Bring this to your J6, S6 to share what you need….

Using technology in a deployed environment may be a challenge to conduct in an area of operations (AO). Electricity and internet connection, while taken for granted in day-to-day life, are often limited resources in the AO and must be considered in the planning process for telemedical support. Technology should not limit teleconsultation but should augment it.

Ultimately, the type of technology you use should match the clinical question at hand and will be limited by the power, network, and equipment available.

- Use photographs and asynchronous technologies (e.g., e-mail, text) for routine problems or simple updates to a remote expert for their situational awareness. Slow internet connections will delay transmission of images especially ones of sufficient quality to be used. Dermatologic problems, for example, are well suited for using asynchronous technology to make diagnoses and care plans.
- Use synchronous technologies (i.e. phone) to discuss problems like diagnostic dilemmas, care plans with complex risk-benefit tradeoffs, problem solving for management of scarce resources, or timing of patient transport.
- Use video-teleconsultation for procedural telementoring or virtual direct patient care.
- Remote monitoring technology (i.e.telemetry) allows remote experts to help local caregivers identify trends in patient physiology. Using this technology, tele-critical care teams can help local caregivers by monitoring multiple casualties and facilitate better situational awareness. These services may also be utilized to help diminish task saturation (i.e., reduce documentation burden) and enable work-rest cycles.

Minimum: Voice telephone connection with/without asynchronous media to call **ADVISOR** hotline (**1-833-238-7756 DSN: 314-429-9089)** and read from the TCCC card or other form of documentation.

Better: Voice connection WITH concurrent email or photo exchange (i.e., send a photo of the call script, vital signs flowchart, the casualty/care environment, and available kit) closely followed by a phone call. Use a telemedicine report such as the Prolonged Casualty Care (PCC) flowsheet (Appendix B).

Best: Synchronous, real-time audio/video feeds with/without remote diagnostic equipment using the teleconsultation as a guide. If required use the Virtual Critical Care Consultation guide **(**Appendix B) and send a picture of casualty, capabilities, and vital sign trends to the consultant via email or text using operational security and protections of patient privacy.

SOFTWARE

At a minimum, if possible, the local caregiver (LC) and if required, the patient will need access to a secure platform to send messages (picture), make a call or conduct a VTC. There will be times that access to a secure platform is not possible. However, do not delay teleconsultation unless operational situations dictate otherwise (extremely rare). The LC should carefully balance the risk and benefits of waiting for a more secure platform.

HARDWARE

Many HCP/LCs can access TM through secured mobile devices.

- A computer (MC4/NIPR or any CPU) or mobile device
- An integrated or external microphone
- An integrated or external camera

INTERNET

Having a solid internet connection is a crucial piece of successfully accessing telemedicine, especially for telehealth visits conducted by the LC and the patient that require high definition (HD) pictures or a VTC. For Role I/II Access to **NIPR with at least 512kb upload and download speed (1MB preferred),** or **ISP Wi-Fi connection w/same**. Ideally, internet speeds should be at least **15Mbps download and 5Mbps upload**. While video streaming can happen with slower connections and lower definitions (LD), these are the recommended speeds needed to have a clear video experience for the majority of platforms.

APPENDIX D: TAKING GOOD PICTURES

1. Use a well-lit area.
2. Avoid flash photography, if possible.
3. A solid, uniform background is preferred.
4. Have someone else besides the patient take the photograph.
5. If using a cellular phone, use the main (rear-facing) lens, not the "selfie" lens.
6. Make sure the area of involvement is well focused; don't get too close if this makes the image out of focus.
7. For individual lesions, make sure the whole lesion is in the picture.
8. Use a ruler in the image (or, if a ruler is not available, a common object such as a coin) to demonstrate the size of the lesion.
9. For rashes, get a distance view that shows the pattern of the rash and a close-up view that shows the character of the rash.
10. More in-depth training for medical photography on JKO: DHA-US472 Virtual Medical Digital Photography

APPENDIX E: COMMON TELECONSULTATION DEFINITIONS

Asynchronous Communication - unidirectional information flow (i.e., text, e-mail), sometimes known as store and forward, refers to telemedicine that is delivered at a later time from when the patient or another healthcare provider requests it. This could be text-based interactions, a specialist reviewing labs or records at a later time, or a patient conducting an online assessment for medications.

Bandwidth - the amount of information that may move through a network at any point in time. Think of it like a door or a turnstile: only one or two people can fit through at a time. Similarly, packets of digital information flow through wires and those wires, or their connections, are limited in size and thus only allow a certain amount of information to pass through them at a time. Thus, packets must "get-in-line" such that some arrive to their destination before others. If the network is not "point-to-point" and serves multiple users, then these users must share the bandwidth. Some information on the network can be considered "higher priority" than other information. Quality of services protocols allow certain types of information or information from a particular source/user to move more freely (i.e. may go to the "head of the line") than other information.

Consultant/Expert- the clinician who receives the consult from the local caregiver. This may be a designated consultant in a formal system, or a validated and/or trusted expert provider chosen by the local caregiver

Distant Site- a distant site is the location the telemedicine provider is in at the time of remote patient service. Sometimes this is referred to as the consulting site.

Extended consultation- emergent consultation is for patients with critical illness or injury. This concept reflects clinical engagement more than communication modality. This refers to a consultant/expert who remains engaged with the care of a local patient or local patients over time by monitoring physiologic vital signs, audio channel(s), video feed(s), or combinations of these technologies.

Latency - the amount of time it takes information to travel from origination to destination. Most of the time, digital information travels quickly, even across hundreds of miles of distance. Still, using satellite communication to move from one side of the globe to the other, or from the moon to the earth, delays receipt of information. Information may also be slowed if it must pass through filters, firewalls, or scanning software.

Local Caregiver- the person (not necessarily someone with medical training) who is taking care of a patient and who initiates teleconsultation.

Originating Site- the originating site is the location the telemedicine patient is in at the time of remote patient service.

Remote Patient Monitoring- remote patient monitoring refers to technology and programs that help track patient health data at a distant site outside of the hospital or clinic and send that data to care providers in real time. This technology could be in the form of connected healthcare devices like a smartwatch or heart monitor, health monitoring and wellness apps, or connected home devices. Remote monitoring patient data can include vital signs, weight, blood pressure, blood sugar, and other inputs like behavioral health data or symptoms.

Routine consultations are those that do not require immediate assistance. Routine consultations may take many hours to receive a response from a specialist (4-24 hours; median response time is approximately 4 hours).

Synchronous Communication- bidirectional information flow (i.e. voice, video, both). Synchronous telemedicine refers to telemedicine that is performed in real-time via video or phone consult. In practice, this looks like an urgent care provider assessing symptoms of a sore throat and fever, a psychiatrist managing a patient's medication, or a primary care provider conducting a follow-up visit with a patient.

Telemedicine- remote evaluation, diagnosis, treatment, and/or consultation using telecommunications technologies. Telemedicine is a subset of telehealth referring to the specific delivery of clinical healthcare services through telecommunications platforms. Examples of telemedicine could be video consults, phone consults, or patient-provider communication through text messages or a patient portal.

Teleconsultation – or "eConsult" is a caregiver to remote expert discussion about a patient's diagnosis, diagnostic plan, treatment, or management plan using telecommunications technology such as a call, text, video consult, etc.

Urgent non-critical care specialty consultations are those in with remote consultants need to speak with a specialist in order to best manage a patient within hours. This could be a patient related need (i.e. the patient may worsen in the next several hours) or mission specific need (i.e. there is a short communications window or there is a mission essential decision to make like "does this casualty need to get on the evacuation platform that is leaving in the next hour or can he/she continue mission until the next available evacuation time").

VTC – video teleconferencing is the ability to share audio and video signal between two locations to conduct real-time communication. This includes point-to-point (one location communicates to only one other location at a time) and multi-point (multiple locations communication with multiple other locations simultaneously).

APPENDIX F: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

CRITICAL CARE AIR TRANSPORT CLINICAL PRACTICE GUIDELINE

TRANSCUTANEOUS & TEMPORARY TRANSVENOUS PACING (CPG ID:50)

The goal of this clinical practice guideline (CPG) is to optimize care of patients with hemodynamically significant bradycardia in the aeromedical environment. The series is developed by the Center for Sustainment of Trauma and Readiness Skills and derived from the Tactical Critical Care Evacuation Course.

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Major updates

1. A discussion of transcutaneous pacing and indications for the prophylactic placement of a transvenous pacemaker has been included.
2. An overview of physiology of transcutaneous and transvenous pacemakers has been added.
3. Algorithms for loss of capture for transcutaneous and transvenous pacemakers have been developed.
4. An appendix detailing how to program the Medtronic 5388 transvenous pacer has been developed to review the most commonly used dials to make appropriate setting adjustments.

Goal

The goal of this guideline is to provide a review of the physiology, indications, and algorithms for troubleshooting transcutaneous and transvenous cardiac pacing systems. A pre-flight checklist has been developed for patients that are to be evacuated. The algorithms to troubleshoot pacemaker malfunction also include the special conditions encountered by en route care personnel. Appendix A includes a basic transvenous pacemaker programming instruction set. However, it is not intended to replace the device manual.

Background

Myocardial infarction (MI) occurs relatively frequently in the deployed setting, therefore, En Route Critical Care (ERCC) personnel must be familiar with the treatment of its complications. Unstable bradycardia is one such complication, making temporary cardiac pacing a required skill for all deploying providers. Team members need be familiar with the indications for intravenous and transcutaneous cardiac pacing. They must also be to troubleshoot pacemakers in the austere locations within which they operate. For example, electromagnetic radiation from aircraft electronics and RADAR can interfere with transvenous pacemakers and place patients at risk during transport; ERCC personnel must also understand the transvenous pacemaker modes that mitigate the effects of aircraft electromagnetic interference (EMI).[1]

The pacemaker technologies available downrange include temporary transcutaneous and temporary transvenous pacing systems. Portable transcutaneous pacemakers are found at Role1, 2, and 3 facilities, as well as on various Aeromedical Evacuation (AE) platforms. Some Role 3 facilities have the additional capability of placing a temporary transvenous pacemaker before patient evacuation. En route care personnel must be familiar with both types of temporary pacing technologies: transcutaneous and transvenous.

Temporary cardiac pacemakers are only bridges to definitive care. Patients with hemodynamic unstable bradycardia often require cardiac catheterization, advanced cardiac electrophysiologic studies, and potentially permanent pacemaker placement. None of these medical capabilities are available downrange. Therefore, patients who require temporary pacing should be categorized as “urgent” for evacuation purposes, as mortality and morbidity are increased if definitive care is delayed.[2]

If the ERCC provider is not experienced with managing or troubleshooting a transvenous pacemaker, the theatre cardiologist may be brought on the flight as mission-essential-personnel (MEP) to augment the ERCC team. If a theater cardiologist is not available, the global cardiologist consult service

(cards.consult.army@mail.mil) can be utilized to help formulate the best care plan given that equipment and resources available.

The physiology, indications, and complications associated with temporary cardiac pacing will be discussed below. There will also be a focus on special considerations associated with AE.

Physiology of Noninvasive Transcutaneous Pacing

Both the right and left ventricles are stimulated with transcutaneous pacing. The atria are frequently stimulated in a retrograde fashion; this produces atrioventricular dyssynchrony which decreases cardiac output by about 20% from the loss of an atrial kick. Although a patient with symptomatic bradycardia will experience an increase in cardiac output and mean arterial pressure because of pacing, the cardiac output will not usually return to pre-bradycardia levels. This 20% cardiac output decrease, however, will usually be well tolerated unless left ventricular function is severely diminished.[3]

Studies have demonstrated that transcutaneous pacing does not injure the myocardium and from this perspective there is no time limit associated with transcutaneous pacing. Capture rates with the Zoll MD monitor (used by ERCC) are high and vary according to the device and patient population; some published capture rates are up to 96%, although this may be best case scenario.[4] Limitations of transcutaneous pacing include skin damage and patient discomfort.

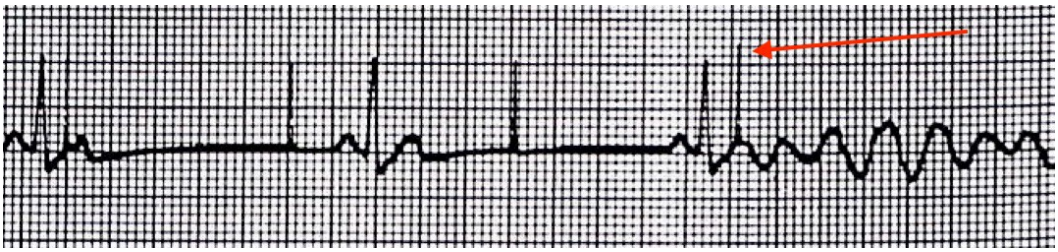
Physiology of Transvenous Pacing

Transvenous pacemakers can do two things: (1) pace the heart and (2) sense the intrinsic cardiac rhythm. Unlike transcutaneous pacing, a transvenous pacemaker can pace the atrium, ventricle, or both; the term dual chamber pacemaker is used when both the atrium and ventricle can be stimulated. Depending on the clinical circumstance and the pacemaker settings, a dual chamber pacemaker can maintain atrioventricular synchrony and therefore cardiac output.[5]

The transvenous pacemaker can pace the heart at a fixed rate regardless of the underlying heart rhythm; this is termed asynchronous. It can also sense the heart's electrical activity to determine if it is necessary to stimulate a cardiac contraction to maintain a predetermined heart rate; this is termed synchronous. Therefore, in the synchronous mode the pacemaker does not fire if the intrinsic heart rate is above a predetermined value. In the asynchronous mode, the pacer fires at a fixed rate regardless of the underlying rhythm.

The entire point of pacemaker sensing is to avoid the R-on-T phenomenon (he superimposition of an ectopic beat on the T wave of a preceding beat) that can degenerate into ventricular tachycardia/ventricular fibrillation (VT)/(VF) (see red arrow in Figure 1 below). This is because a "sensing" pacemaker will not produce an electrical impulse that is "too close" to an intrinsic cardiac contraction. Therefore, any environment that interferes with a pacemaker's ability to sense properly will place the patient at risk for VT/VF. Two clinical settings found downrange that can disrupt pacemaker sensing are (1) the operating room and (2) the AE environment; in both situations EMI is the culprit.

Figure 1. An example of R-on-T from a pacemaker



The asynchronous mode protects the patient from R-on-T when the pacemaker is not sensing correctly, the pacemaker rate is set ***higher*** than the patient's intrinsic heart rate. In this mode, the provider becomes the sensor.

To avoid VT/VF, it is imperative that the pacemaker rate be set to a value greater than the patient's intrinsic heart rate; this also applies to transcutaneous pacing.

Important Contraindications Specific to Transvenous Pacemakers:[1]

- Asynchronous pacing is contraindicated in the presence of intrinsic cardiac rhythms, unless there is EMI that renders the pacemaker's ability to sense the heart's intrinsic electrical activity ineffective.
- Atrial pacing is ineffective in the presence of atrial fibrillation or flutter.
- Single chamber atrial pacing is contraindicated in the presence of AV conduction disorders.
- Pacing modes that allow sensing in the atrium to trigger a ventricular response are contraindicated in the presence of rapid atrial arrhythmias such as atrial fibrillation or atrial flutter.

Complications of Temporary Transvenous Pacing

Conventional temporary transvenous pacing is associated with substantial complications, including local infection, thrombosis, and a lead dislodgement rate ranging from 10 to 37%.[5]

Lead dislodgment highlights the importance of having a transcutaneous pacing system in place at all times, particularly in-flight where patient transfers and movement may increase the dislodgement rate.

Temporary Pacing & Prophylactic Transvenous Pacemaker Placement

Indications for Temporary Cardiac Pacing[6]

Indications for pacing a patient with bradycardia are hemodynamic instability (hypotension), acute altered mental status, ongoing severe ischemic chest pain, congestive heart failure, syncope, 3rd degree heart block, bradycardia unresponsive to drug therapy, or other signs of shock.

Boluses or infusions of chronotropic medications, such as atropine, epinephrine, dopamine, or isoproterenol may be considered before initiating pacing. Note that atropine, however, is typically not effective for Mobitz type II and complete heart blocks. Do not delay initiating pacing with signs of shock if bolus medications are not immediately available.

Sinus bradycardia is common shortly after ST elevation MI (STEMI), particularly after inferior wall infarcts; if symptomatic, atropine may be used followed by temporary transcutaneous pacing if necessary.

Indications for Prophylactic Transvenous Pacemaker Placement[6]

The incidence of complete heart block is nearly 4% with inferior/posterior MI. In certain cases, a transvenous pacer may need to be placed before flight after discussion with the theatre cardiologist.

Prophylactic placement of a temporary transvenous pacing system is recommended for high-grade AV block and/or new bundle-branch (particularly with LBBBs) or bifascicular block in patients with anterior/lateral MI.

High-grade AV block with inferior/posterior STEMI usually is transient and associated with a narrow complex/junctional escape rhythm that can be managed conservatively. Application of transcutaneous pacing pads for potential use is reasonable in the hospital setting; a discussion with cardiology as to whether a transvenous pacing system should be placed prophylactically before evacuation should occur.

Bradyarrhythmias are common with right heart MI's. An adequate heart rate is essential to maintain cardiac output with right ventricular dysfunction. Transvenous pacer placement before flight should be considered if bradyarrhythmias are present. However, it may prove problematic with an ischemic right ventricle: be prepared to pace transcutaneously.

Another indication for transvenous pacing is if the patient is too diaphoretic to allow good electrode-to-skin adhesion for transcutaneous pacing. Large pectoral muscles also increase capture thresholds; therefore fit muscular patients may be better served with a prophylactic transvenous pacemaker in certain cases. Cardiology should be included in the decision when planning these for contingencies.

As a general rule, transcutaneous pacing should not be maintained for longer than 24 hours without converting to a transvenous pacemaker.

Pacing Equipment Available to ERCC

ERCC personnel must be familiar with the operation of the Zoll MD Monitor. Transcutaneous pacing is performed with the monitor and dermal electrodes during patient movement by ERCC.

The portable transvenous pacemaker generator currently stocked downrange is the Medtronic 5388 dual chamber pacemaker unit. ERCC members should also become familiar with this unit prior to transporting a patient. Appendix A will highlight some important programming aspects of the Medtronic 5388, to include safe modes to mitigate EMI's negative effects. The appendix is not meant to replace the device's user manual. All ERCC personnel should review the manual before deploying; the link to an electronic copy on the Medtronic website is:
http://manuals.medtronic.com/wcm/groups/mdtcom_sg/@emanuals/@era/@crdm/documents/docume nts/198092001_cont_20071214.pdf

Pre-flight Checklist & Considerations for ERCC Movement

1. A chest x-ray should be done to verify correct transvenous pacer placement and to exclude pneumothorax from pacer placement.

2. A 12-lead ECG and pulse exam should be performed to confirm consistent mechanical capture.

3. Consider pre-flight intubation if transporting a patient requiring transcutaneous pacing. Transcutaneous pacing is painful and will require analgesia and sedation; this is more easily accomplished in the intubated patient. Note that the force of the skeletal muscle contraction, rather than the pacemaker's output in mA, predicts patient discomfort. Discomfort appears to be inversely related to age, possibly due to the older patient having less muscle mass. Therefore, young muscular males may be the most susceptible to transcutaneous pacer intolerance.

4. ERCC personnel should not perform transvenous dressing changes in-flight. If appropriate, have the Role III nurse change the dressing prior to departure.

5. Secure the TVP unit directly to the patient, ensuring it does not fall during patient movement, which could potentially cause lead displacement and loss of capture.

6. A central line and arterial line should be placed prior to flight. If the symptomatic bradycardia is secondary to an acute MI, ensure central and arterial lines are placed at compressible locations if full anticoagulation and/or fibrinolytics may be used.

7. Correct all electrolytes pre-flight to include potassium, magnesium, calcium and phosphorous. Potassium and phosphate replacements are not in the ERCC allowance standard and must be obtained from the Role III prior to departure.

8. Review all cardiac studies to include ECGs, echocardiogram results, and troponin levels.

9. Plan for pacing system malfunction by obtaining (or preparing) infusions of chronotropic medications: epinephrine, dopamine, or isoproterenol. Isoproterenol must be obtained from the Role III as it is not included in the ERCC allowance standard.

10. A request for the Role 3 cardiologist to accompany the AE as mission-essential-personnel (MEP) is possible if the ERCC physician has limited experience with transvenous pacing.

11. After the patient has been transferred to the aircraft, reassess all leads and connections to ensure electrical capture and check a pulse to verify that mechanical capture has not been lost during patient movement on the ground.

12. Patients being paced require continuous and close observation because pacing thresholds can increase over time; patients should be monitored to ensure continuous mechanical capture during flight.

13. An extra battery for the transvenous pacing unit should be taped to the back of the unit or kept immediately available. Confirm that the battery is fully charged prior to departure.

Plan for Loss of Capture with Transcutaneous Pacing In-flight

- Good skin-to-electrode contact lowers transthoracic impedance and improves electrical capture of the heart. All chest hair under the electrode should be clipped or removed.
- Replace pacer pads every 24 hours, regardless of if they are being used. The accumulation of sweat under the pads can result in loss of capture if pacing is initiated.
- Moving the posterior electrode to the right of the spine increases the capture threshold by 15%, as compared to placement over the spine. Therefore, to maximize capture the posterior pad should be under the right scapula.
- Higher capture thresholds for transcutaneous pacing have been found in patients with the following factors: hypoxia, acidosis, pulmonary emphysema, pericardial effusion, large pectoral muscles, and certain medications (e.g., antiarrhythmics, beta blockers, calcium channel blockers).

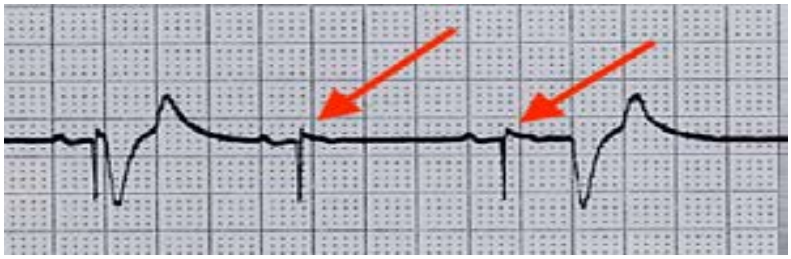
Steps to take for failure to capture in-flight are:

1. Increase the mA until electrical and mechanical capture are confirmed.
2. Make sure the pacing electrodes are well adhered to the skin.
3. Check for correct placement of the electrodes (posterior electrode under the right scapula). You may find the posterior electrode in the litter when the patient is diaphoretic or restless.
4. Move the pacing (negative) electrode to another place on left precordium.
5. Treat any acidemia and/or hypoxemia present.
6. Consider an infusion of a chronotropic agent if the above steps fail to achieve capture; also consider flight diversion. An in-flight cardiology consult would be appropriate.
7. ***Intermittent loss of capture must be addressed urgently, as sudden and complete loss of capture will likely result in asystole.***

Plan for Loss of Capture with Transvenous Pacing In-flight

An example of loss of capture with ventricular pacing is shown in Figure 2. ***Note****: only the first QRS complex is associated with a pacing spike, the red arrows mark "pacing spikes" that do not capture.*

Figure 2. Ventricular loss of capture



All patients requiring temporary transvenous pacing should be transported with transcutaneous pads in place and connected to a monitor that has external pacing capability. The monitor should be preprogrammed so immediate transcutaneous pacing can be initiated. If the temporary pacemaker is discontinued abruptly, asystole may result.

Steps to take for failure to capture in-flight are:

1. Check the battery and replace as needed. Transcutaneous pacing may be required until completed. The battery should be checked twice daily.

2. Increase the mA, then decrease the sensitivity to zero.

3. If the catheter has a balloon, it should be inflated (with saline) and the catheter advanced to regain capture; once capture is obtained the balloon should be deflated. Sometimes, however, the catheter requires withdrawal (with the balloon down) to regain capture. For these maneuvers, the pacer catheter should have been placed through a sterile sleeve so that in-flight adjustments can be easily done. The provider must understand the risks associated with catheter advancement and withdrawal (i.e. cardiac perforation). The back-up plan to catheter adjustment is transcutaneous pacing, which may be the safest option depending on the clinical scenario and experience of the provider.

4. Consider an infusion of a chronotropic agent if the above steps fail to achieve capture; also consider flight diversion. An in-flight cardiology consult would be appropriate.

5. Treat any acidemia and/or hypoxemia present.

Intermittent loss of capture must be addressed urgently, as sudden and complete loss of capture will likely result in asystole.

Placement of Transvenous Pacing System

- Placement of a temporary transvenous pacemaker requires central venous access with a 6.0 French (Fr) percutaneous introducer catheter. If an 8.5Fr introducer is used (typically used in trauma resuscitations), it may leak blood from around the pacing catheter.
- Catheter placement in the right internal jugular vein is preferred. Placement in the left subclavian is also acceptable, but this location should be avoided in patients who are being anticoagulated or who may need fibrinolytics. Fluoroscopic guidance is not absolutely necessary at these pacer insertion locations, but a chest x-ray should be obtained to rule out hemothorax, pneumothorax, and to confirm appropriate position of the pacer wire.
- Standardization of pacemaker catheters across military treatment facilities has not been achieved; review the manufacturer's instructions set prior to using.
- If the pacer catheter has a balloon, it should be inflated (with saline) while the catheter is advanced and capture is obtained. Once capture is obtained, the balloon should be deflated and left deflated. The pacemaker catheter should be placed through a sterile sleeve so that in-flight adjustments can be done easily.

Transvenous Pacemaker Modes

The different modes for transvenous pacing are defined with a three-letter code:

1. First letter defines the area of the heart paced: atrium (A), ventricle (V), or both atrium and ventricle (D).

2. Second letter defines the area of the heart sensed: atrium (A), ventricle (V), or both atrium and ventricle (D).

3. Third letter defines what the pacemaker does with the sensing information. Sensing can result in:

    - Pacemaker being inhibited from firing (letter I used to denote "inhibited").
    - No effect on how the pacemaker fires (letter O used to refer to "none").
    - Both the atria and ventricle are paced (letter D used to refer to atrium and ventricle, or A+V).
    - Only the atrium is paced (letter A used to refer to atrium).
    - Only the ventricle is paced (letter V used to refer to ventricle).

The most commonly used pacing mode for the treatment of bradyarrhythmias is ventricular demand pacing. When it is important to maintain cardiac synchrony (treating a critically ill patient with impaired ventricular function) a dual chamber pacemaker is preferred as it can improve cardiac output by up to 20%. Ventricular demand pacing, however, will be satisfactory for most patients.

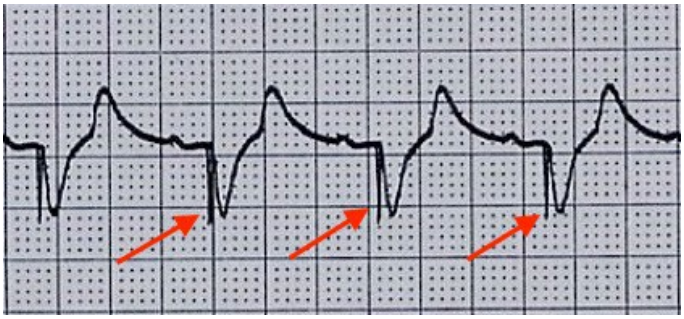
Ventricular demand pacing is the mode of choice during patient evacuations *because attaining the correct electrode position when "floating" the transvenous pacemaker is relatively simple. It will be well tolerated provided that the left ventricular function is not severely depressed. It is also the least sensitive to small changes in catheter positions.*

Settings for temporary ventricular pacing are VVI and VOO.

- In mode VVI (synchronous mode), the ventricle is paced, as well as sensed. If the pacemaker's pulse generator senses an impulse created by the heart, the pacemaker's impulse is not sent, thus the pulse generator is inhibited. This mode is used to prevent R-on-T complications when there is an underlying ventricular rhythm. This is the preferred mode, unless EMI is present.
- In mode VOO (asynchronous mode), the ventricle is paced at a fixed rate and there is no sensing; electrical impulses are delivered regardless of the underlying ventricular rhythm. This mode is best used if electrocautery is being used (during surgery), and during periods of excessive electrical stimulation from EMI due to aircraft electronics. The rate with VOO must be greater than the patient's intrinsic heart rate to avoid R-on-T which can result in VT/VF.

An example of ventricular pacing is shown in Figure 4. Notice the wide QRS complexes; they are normal with ventricular pacing and each "pacing spike" (marked by red arrows) is associated with such a complex.

Figure 4. Ventricular pacing with capture



Transvenous pacemaker modes to use for particular conduction pathologies are summarized in Table 1.

Table 1. Transvenous Pacemaker

Code	Definition	Indication
AOO	Atrial paced, no sensing, no inhibition	Sick sinus syndrome with intact conduction system, use for in-flight EMI
AAI	Atrial paced, atrial sensed, inhibited by atrium	Sick sinus syndrome with intact conduction system
VOO	Ventricular paced, no sensing, no inhibition	Third degree heart block with atrial fibrillation, use for in- flight EMI
VVI	Ventricle paced, ventricle sensed, inhibited by ventricle	Third degree heart block with atrial fibrillation
DOO	Dual paced, no sensing, no inhibition	Third degree heart block without atrial fibrillation, use for in-flight EMI
DVI	Dual paced, ventricle sensed, inhibited by ventricle	Third degree heart block with supraventricular tachycardia
DDD	Dual pace, dual sensed, dual inhibited	Third degree heart block

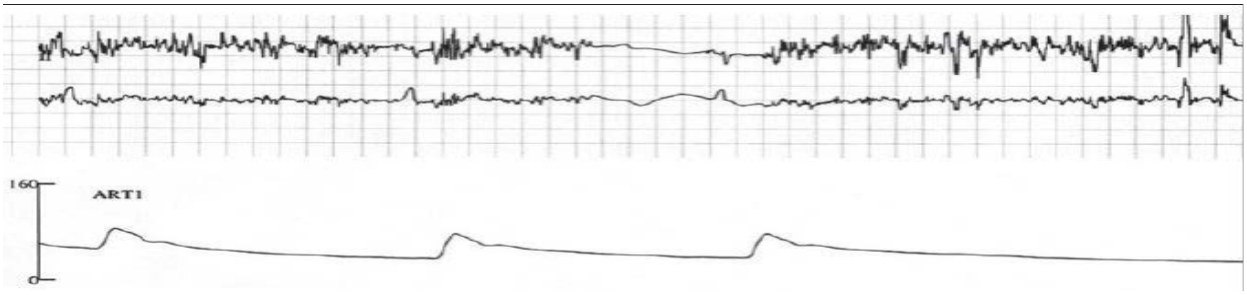
Transvenous Pacing Scenarios with Associated ECG Tracings

(1) Electromagnetic Interference

- If electromagnetic interference is present and inhibiting the pacemaker from firing, then the pacemaker should be switched to an asynchronous mode such as dual- chamber asynchronous pacing DOO or VOO.
- Use DOO for third degree heart block without atrial fibrillation.
- Use VOO for third degree heart block with atrial fibrillation.
- Remember that the rate with VOO and DOO must be greater than the patient's intrinsic heart to avoid R-on-T which can result in VT/VF.

A typical ECG with EMI will look similar to the tracing in Figure 5 below.

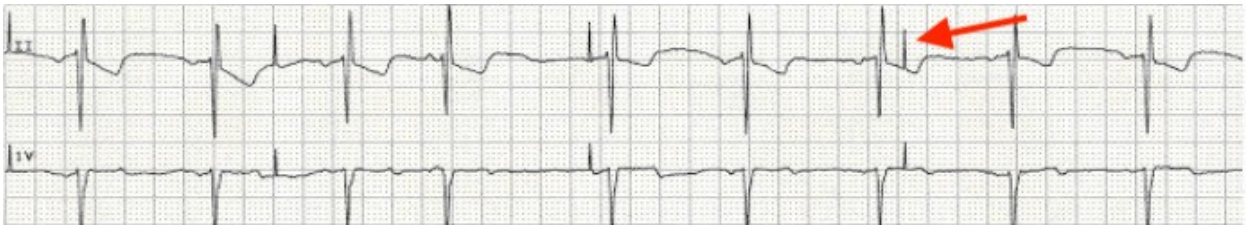
Figure 5. An example of EMI that causes pacemaker inhibition



(2) Failure to sense

Failure to sense (or undersensing) is shown in the Fig. 6. It occurs when the pacemaker fails to recognize spontaneous myocardial depolarization. This is identified by the generation of an unnecessary pacing spike (one that follows too closely behind the patient's QRS complexes). To correct this, consider increasing the sensing threshold, see Appendix A.

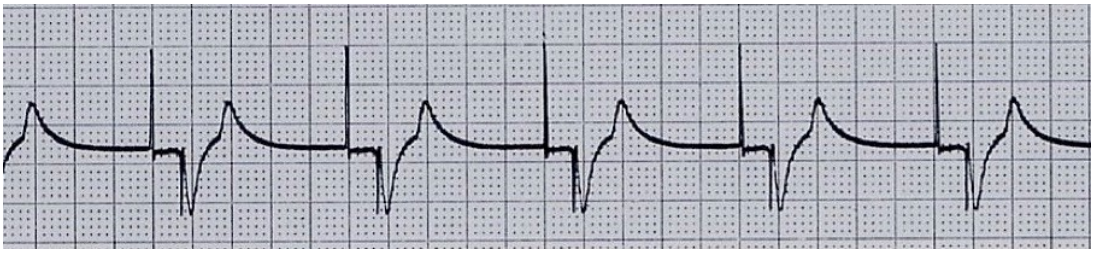
Figure 6. An example of failure to sense (or undersensing)



(3) Loss of capture

An example of loss of atrial capture is shown in Figure 7 below.
Note there are no p waves that follow the "upward" atrial "pacing spikes."
Refer to Appendix A for how to increase the atrial Ma.

Figure 7. An example of loss of atrial capture



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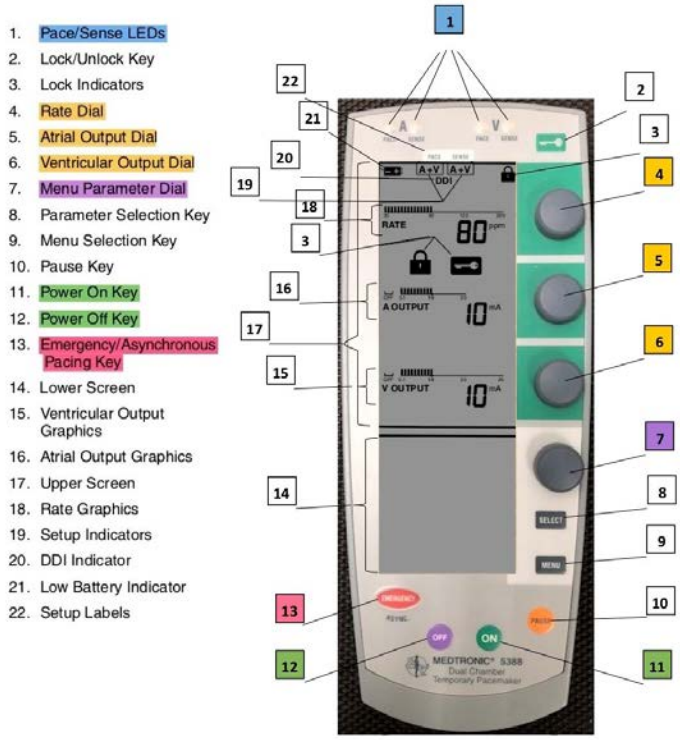
Appendix A: Overview of the Medtronic 5388 Dual Chamber Pacemaker

A schematic of the Medtronic 5388 is shown below (Figure A1); a few selected dials and buttons will be explained within this appendix. The Medtronic manual should be used for a comprehensive review of the device; the manual was used to construct this brief review in the event that the Medtronic manual would be unavailable in the deployed setting.

Figure A1. Schematic of the Medtronic 5388



POWER ON/OFF: The ON button is marked in green (number 11, Figure A1) and the OFF button is number 12 above. Press the ON key once. The upper screen lights up and the pacers initiates a self-test. Once a successful self-test is completed the following occurs: A sufficiently charged battery will allow the device to begin sensing and pacing in both the atrium and ventricle at the following nominal parameter values. Press the "OFF" button twice within 5 seconds. After the first press, a message appears in the lower screen telling the user to press OFF a second time to turn the device off.

Table A1. The power up values for the 5388 dual Medtronic pacemaker

Base Rate	**80 per min**
A output and V output	10 mA and 10 mA
A sensitivity	0.5 mV
V sensitivity	2.0 mV
A Tracking	ON

EMERGENCY/ASYNCHRONOUS BUTTON: Press this key (number 13, Fig A1) once to select high-output, dual- chamber asynchronous (DOO) pacing at any time, whether the device is off or locked. Use caution to avoid accidentally activating the Emergency key. This button should be used if electromagnetic interference causes over sensing inhibiting the pacemaker from firing causing hemodynamic instability. The device will pace at the following values:

Table A2. Emergency Values

Base Rate	**80 per min**
A output and	20 mA
V output	25 mA
A sensitivity	ASYN (no sensing)
V sensitivity	ASYN (no sensing)

Adjusting the rate, A output, and V output in emergency mode: These parameters can be adjusted using the three upper dials (numbers 4, 5, and 6) on the right side of device marked in yellow in Figure A1; these dials will be detailed below. To return the device to demand or synchronous pacing:

- Press the ON key once if the asynchronous pacing message is displayed in the lower screen.
- Press the ON key twice if the asynchronous pacing message is not displayed in the lower screen. The first press of the ON key causes the asynchronous message to appear.
- The number 14 in Figure A1 identifies the lower screen.

The device will begin synchronous pacing with the following values:

Table A3. Current Settings

Base Rate	**Current settings**
A output and	Current settings
V output	Current settings
A sensitivity	0.5 mV (nominal)
V sensitivity	2.0 mV (nominal)

ADJUSTING RATE, A OUTPUT, AND V OUTPUT: the parameter settings are displayed numerically and graphically. The dials for adjustment are the numbers 4, 5, and 6 respectively (marked in yellow, Figure A1). The line next to each dial shows the range available for each parameter. The liner graph appears above the corresponding numerical value.

Rate dial (number 4 in Figure A1): The optimal RATE setting once the device turns on is 80 BPM. The pacing rate ranges from 30 to 200 beats per minute (BPM). Turning the RATE knob clockwise increases the rate, and counter-clockwise decreases the rate.

A (Atrial) OUTPUT dial (number 5 in Figure A1: The atrial output ranges from 0.1 to 20 mA. Turn the dial clockwise to increase A OUTPUT. Turn the dial counterclockwise to decrease or turn A OUTPUT OFF. When A OUTPUT is set to OFF, both the atrial output and the atrial sensitivity are turned off (i.e., there is no atrial pacing or sensing).

V (Ventricle) OUTPUT dial (number 6 in Figure A1): The ventricular output ranges from 0.1 to 25 mA. Turn the dial clockwise to increase V OUTPUT. Turn the dial counterclockwise to decrease or turn V OUTPUT to OFF. When V OUTPUT is set to OFF, both the ventricular output and the ventricular sensitivity are turned off (i.e. there is no ventricular pacing or sensing).

PACE LEDs

- Two green LEDs at the top of the device, marked PACE, number 1 in Figure A1, indicate delivery of a pacing pulse but do not necessarily indicate the pacing pulse has initiated cardiac stimulation.
- The green LED next to the A flashes each time the device delivers a pacing pulse on the atrial channel.
- The green LED next to the V flashes each time the device delivers a pacing pulse on the ventricular channel.

Adjusting Atrial and Ventricular Sensitivities

- The lower screen (number 14, Figure a1) allows adjustment of the atrial and ventricle sensitivities.
- Menu 1 provides access to the:
  - Atrial sensitivity (A SENSITIVITY),
  - Ventricular sensitivity (V SENSITIVITY),
  - A-V Interval (A-V INTERVAL), and
  - Atrial tracking option (A TRACKING).
- Depressing the Menu button (number 9, Figure A1) and then using the Select button (number 8, Figure A1) to choose Menu 1 allows access to change the sensing values for the atrium and ventricle.
- Unless manually adjusted, the atrial sensitivity (A SENSITIVITY) is set to the nominal value of 0.5 mV.
- When selected, the A SENSITIVITY may be adjusted between 0.4 and 10 mV by turning the Menu Parameter dial.
- Unless manually adjusted, ventricular sensitivity (V SENSITIVITY) is set to the nominal value of 2.0 mV.
- When selected, the sensitivity may be adjusted between 0.8 and 20 mV by turning the Menu Parameter dial.

TRANSFUSION FOR THE MILITARY WORKING DOG

Publication Date: 10 Dec 2019, CPG ID:77

Photo credit: US Military Working Dog Teams National Monument, Lackland AFB, TX

These clinical practice guidelines focus on transfusion for military working dogs injured as the result of trauma in a forward deployed environment and will focus only on canine blood products expected to be found in theater.

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INTRODUCTION

Military Working Dogs (MWDs) are at the same risk for injury as their human counterparts and when they are severely injured, best practice for resuscitation mirrors those recommended for humans.[1] A recent study of trauma in MWDs shows that explosions, gunshot wounds and lacerations account for the vast majorities of injuries sustained within the Central Command area of responsibility.[2] In severe cases, these mechanisms of injuries could require resuscitation with blood products.[3,4] Hemostatic resuscitation has been shown in a many species to be superior to resuscitation with crystalloids or synthetic colloids[5,6] and should therefore be considered the first-choice resuscitation product in severely wounded MWDs.

Note: only canine blood products should be considered for transfusion to an MWD as transfusion of human blood products into canines carries a high likelihood of an incompatible hemolytic reaction. [7]

INDICATIONS

Transfusion therapy is indicated for MWDs experiencing any condition (trauma, neoplasia, other) that results in acute blood loss or clinical anemia, or that significantly increases their bleeding risk (e.g., severe thrombocytopenia, Acute Traumatic Coagulopathy/Trauma-Induced Coagulopathy,[8] other). Consider transfusion therapy as a first-line intervention for perioperative hemodynamic optimization in MWDs that have suffered major trauma. These guidelines focus on transfusion for MWDs injured as the result of trauma in a forward deployed environment and will focus only on canine blood products expected to be found in theater – specifically canine Whole Blood, Fresh Frozen Plasma and Freeze Dried Plasma. These guidelines should therefore not be used for all conditions.

Table 1. Definitions

Definitions
Acute Blood Loss/Hemorrhage indicated if one or more of the following: • Estimated or anticipated **blood loss > 20%** of estimated total blood volume (eTBV),   • ~ 400 – 500 mL in a 25 kg MWD based on eTBV of 85 mL/kg in MWDs. • Systemic signs of hypoperfusion (See Table 6.) • SBP < 90 mm Hg or drop in SBP by ≥ 30 mm Hg • Shock index (SI) > 1.0 - (Heart rate/systolic blood pressure)[9] • Hypothermia (< 99°F or < 37°C) • Hyperlactatemia (≥ 5 mmoL/L) and / or Base Excess -6.6 or lower

Clinical Anemia resulting in:
• Tachycardia (HR ≥ 160 ± 20 beats/minute) ± bounding femoral pulses
• Pale to white mucous membranes
• Depressed mentation
• Hematocrit <20%, Hemoglobin < 7 g/dL
Note: the above values are not transfusion triggers in dogs. Clinicians are encouraged to use multiple clinical and laboratory values to determine the need for transfusion in an anemic dog.
• Presence of worsening anemia with signs of impaired oxygen delivery:
  • Hypoxemia (SpO2 < 90%, room air)
  • Elevated RR (> 40 breaths/min) with increasing respiratory effort

Definitions

Clinical Coagulopathy
• Clinical signs of spontaneous hemorrhage with one of the following:
  • Viscoelastic tracing (thromboelastography and rotational thromboelastometry [TEG / ROTEM]) demonstrating decreased clot strength of < 40% of mean reference value [(ROTEM - Maximum Clot Firmness (MCL) or TEG - Maximal Amplitude (MA)]
  • Prolonged coagulation assays (activated Partial Thromboplastin Time [aPTT]; Prothrombin Time, [PT]) > 1.5 times the mean laboratory reference interval.

Standard transfusion triggers are generally not applied to canine medicine but rather the clinical condition of the MWD is assessed to determine the appropriateness of a transfusion. The following should be considered in the assessment for blood transfusion needs in a MWD:

Table 2. Mechanism of injury, anatomical site and severity of injury

Mechanism of injury, anatomical site and severity of injury

1. **Mechanism of injury (MOI)**
  a. Blunt* - Vehicular, primary blast injury.
  b. Penetrating*
  • Stabbing, ballistic, impalements, bite wounds, secondary blast injury.
  • Higher-velocity, higher-kinetic-energy vs. low-velocity, lower kinetic
  c. Other: Acceleration/deceleration; shear; and crush.
 	
*Major trauma from blunt or penetrating MOIs present the greatest risk for massive hemorrhage warranting transfusion needs.[3]

2. Anatomical location: Internal versus External
  a. Cavitary bleeding (thoracic, peritoneal, retroperitoneal) is considered a major source of hemorrhage in trauma patients.
  b. Canines suffering blunt trauma to the abdomen have a higher risk for mortality due to unrecognized internal bleeding.[10]

3. Severity of Trauma
  a. Polytrauma
  b. Modified Animal Trauma Triage (ATT) score (see Table 4). [10,11]

Used collectively, the MOI (e.g., blunt force from primary blast wave), anatomical injury patterns (e.g., thoracic versus abdominal), external physical examination findings (e.g., bruising around the umbilicus, distended abdomen with positive fluid wave test, localized pain or tenderness, etc.) and accompanying vital parameters may increase the index of suspicion and direct attention to the most likely sources of occult hemorrhage.

Table 3. Physical parameters and laboratory indicators to evaluate the presence of hemorrhagic circulatory shock warranting hemostatic resuscitation

Physical parameters and laboratory indicators to evaluate the presence of hemorrhagic circulatory shock warranting hemostatic resuscitation
1. Physical: a. Mentation b. Heart rate (HR) and rhythm, Capillary Refill Time (CRT) and mucous membrane color (MM) c. Femoral pulse rate and quality d. Rectal temperature e. Respiratory rate (RR) and respiratory effort
2. External Injury patterns Bruising around the umbilicus, distended abdomen with positive fluid wave test, localized pain or tenderness, other.
3. Laboratory and Diagnostic findings a. Packed cell volume (PCV) and Total solids (TS) b. Lactate and Base Excess (BE),[12] venous or arterial c. Pulse oximetry (SpO2) d. Systolic Blood Pressure (SBP) e. Shock index (SI)
4. Coagulation: a. Coagulation assays (aPTT; PT) b. Viscoelastic tests (e.g. TEG®, ROTEM®, Sonoclot®) c. Platelet counts d. Fibrinogen
5. Diagnostic imaging a. Survey radiographs b. Focused Assessment with Sonography for Trauma (FAST)[13] • Abdominal FAST (AFAST) with abdominal fluid score (AFS) • Thoracic FAST (TFAST) – Pericardial site and Diaphragmatic-hepatic site
6. Other Abdominocentesis or Diagnostic Peritoneal Lavage (DPL) with body cavity fluid analysis.
***Note**: Although many of these modalities are not available at the point-of-injury, they may become available as the MWD casualty is transported to higher roles of medical care.*

Table 4. Modified Animal Trauma Triage (ATT) Score

Modified ATT Score[11]	
Perfusion	
MM pink/moist, CRT 2 sec, T ≥ 100F, strong or bounding femoral pulse quality	0
MM hyperemic **or** pale pink, MM tacky, T ≥ 100F, CRT 0–2 sec, fair femoral pulses	1
MM very pale pink & tacky, CRT 2–3 sec, T < 100F, detectable but poor pulses	2
MM gray/blue/white, CRT > 3 sec, T < 100F, non-palpable femoral pulses	3
Respiratory	
Regular respiratory rate with no stridor, no abdominal component to respiration	0
Mild increased respiratory rate and effusion, ± abdominal comp, mild upper airway sounds	1
Mod increased respiratory rate and effort, some abdominal component, elbow abduct, mod increased upper airway	2
Marked respiratory effort **or** gasping/agonal respiratory, little/no air passage	3
Neurologic	
Central: consciousness: alert to slightly dull, interest in surrounding. Peripheral: normal spinal reflexes; purposeful movement and nociception in all limbs.	0
Central: dull/depressed/withdrawn. Peripheral: abnormal spinal reflexes with purposeful movement and nociception intact in all 4 limbs.	1
Central: unconscious, responds to noxious stimuli. Peripheral: absent purposeful movement with intact nociception in 2 or more limbs **or** nociception absent in 1 limb, decreased anal or tail tone.	2
Central: nonresponsive to all stimuli, refractory seizures. Peripheral: absent nociception in 2 or more limbs, absent tail or perianal nociception.	3
***Score 0–3 (3 = most severe)** for each of the above 3 categories. Increased ATT score equates to more severe injury.	

Table 5: Diagnostic Recommendations

Diagnostic Recommendations
• Obtain serial (not a one-time measure) PCV and total solids to help assess the degree of ongoing hemorrhage. It is important to interpret the PCV in light of the TS concentration, and the acuteness of the blood loss.
• Incorporate serial measurements of base excess and lactate in conjunction with traditional clinical perfusion parameters (e.g., heart rate, pulse quality, mucous membranes, capillary refill time, mentation, body temperature, and arterial blood pressure) as end points of perfusion. • Monitor for changes in vital signs and laboratory parameters that indicate progressing hypoperfusion such as increasing heart or peripheral arterial pulse rate with decreasing peripheral pulse strength, pale MM, prolonging CRT, and worsening anemia and lactate /BE values.
• Utilize FAST to evaluate the abdominal cavity, retroperitoneal space, pleural space, gastrointestinal tract, and fascial planes around fractured bones for areas of "hidden" ongoing hemorrhage that may lead to life-threatening hemorrhagic shock.

• Conduct serial assessments to evaluate whether cavitary effusion is developing or worsening over time.
• Use viscoelastic tests, when available, to identify the presence of a coagulopathy, predict transfusion needs, and evaluate the response to therapy. • When viscoelastic tests are not available, transfuse blood products as needed to maintain PT and aPTT <1.5× of mean reference values.
• Consider ongoing retroperitoneal hemorrhage for any blunt abdominal trauma patient with refractory hemorrhagic shock and declining PCV/TP values, but no significant findings on abdominocentesis, DPL, or AFAST.
FAST - Focused Assessment with Sonography for Trauma; **PT** – Prothrombin Time; **aPTT** – activated Partial Thromboplastin Time; **DPL** – Diagnostic peritoneal lavage;

Table 6: Clinical and diagnostic considerations for predicting transfusion needs

Clinical and Diagnostic Considerations for Predicting Transfusion Needs
General
• MWDs that present with overt hypotension or a high shock index consider early institution of hemostatic resuscitation (transfusion therapy is preferred to crystalloid as the initial resuscitation fluid for management of hemorrhagic shock).
• Common clinical manifestations in canine trauma patients warranting blood transfusions, include[3]: • **Tachycardia** (160 $\pm$ 20 beats/pulses per minute) • **Tachypnea** (> 40 breaths per minute) with increased respiratory effort. • **Hypothermia** (< 99°F or < 37°C) • **Hyperlactatemia** (≥ 5 mmoL/L)
• In face of major blunt or penetrating trauma, a **SI > 1.0** is a sensitive and specific adjunct tool for detecting acute small volume blood loss in dogs. It serves as a more valuable diagnostic assessment for detecting acute occult blood loss, as compared to assessing HR and SBP alone. Consider this a useful tool for the early identification of MWDs that are at risk for ongoing blood loss and decompensatory shock.[9]
• Canines experiencing major trauma may present or become **hypocoagulable**. These trauma-associated coagulopathies are **positively correlated** with the incidence of hemorrhage and transfusion requirements.[14]

Clinical and Diagnostic Considerations for Predicting Transfusion Needs

- Highly consider blood transfusion in MWDs experiencing major trauma that have **evidence of shock** or **worsening anemia** and /or as a requirement for **perioperative hemodynamic optimization**.[3]
  - Clinical signs indicative of hemorrhagic shock vary greatly and are not always readily recognizable; particularly, in the presence of intracavitary hemorrhage (pleural, peritoneal, or retroperitoneal).
  - Early identification of internal hemorrhage remains a challenge without the use of advanced imaging modalities (e.g., focused assessment with sonography for trauma, computed tomography). Casualties with severe internal hemorrhage may succumb to hypovolemic shock before a medical provider realizes the presence and extent of internal bleeding.
  - A hands-on physical examination has a low sensitivity for identifying internal bleeding, particularly, in patients suffering only blunt trauma with no external injuries; however, **despite the absence of external injuries, internal hemorrhage is likely in any casualty suffering major blunt force or penetrating trauma with accompanying signs of circulatory shock (i.e. tachycardia, pale mucous membranes, prolonged capillary refill time, poor femoral artery pulse quality, depressed mentation, cold extremities).**
  - Anatomical injury patterns (thoracic and abdominal trauma) with supportive physical examination findings (e.g. bruising around the umbilicus, distended abdomen with positive fluid wave test, localized pain or tenderness, etc.) may also direct the provider's attention to the most likely areas to explore for sources of internal hemorrhage.

- Remain cognizant of occult hypoperfusion (cryptogenic shock) from ongoing hemorrhage, particularly, in MWDs with blunt abdominal trauma.
  - Although, overt hypotension is the most widely recognized sign of circulatory shock, it is also indicative of more advanced shock.
  - Traditional vital signs (HR and blood pressure) may not always serve as reliable markers of blood loss and decreased perfusion due to rapid activation of compensatory mechanisms.

PCV and TS interpretations

- Serum PCV / TS are specific but insensitive predictors of subsequent transfusion in dogs.

- Trauma patients with severe, acute hemorrhage may require transfusions at **much higher PCVs** than patients with more chronic disease or less systemic compromise.[12]

- In acute hemorrhage, PCV and TS values initially remain within reference intervals due to the loss of red blood cells and plasma in equal proportions. As time elapses, the PCV may initially remain within (or even above) the laboratory reference range while the TP values progressively declines.
- The discrepancy in PCV and TS is subsequent to: a) splenic contraction-induced autotransfusion fostering a normal to high PCV, in conjunction with b) transcapillary fluid shifts from the interstitial to the intravascular space causing a dilutional effect on remaining serum protein concentrations.
- Eventually, both PCV and TS values decrease as hemorrhage and subsequent fluid resuscitation ensues. Declining peripheral PCV/TP values with increasing progressive signs of circulatory shock and increasing body cavity effusion is an indicative finding of ongoing, active intra-cavity hemorrhage.

Clinical and Diagnostic Considerations for Predicting Transfusion Needs
• In the context of trauma, suspect acute blood loss in any polytrauma patient that **presents with a "low, normal or high" PCV and a low TS (≤ 4.5 g/dL).**
• Declining peripheral PCV/TS values with increasing abdominal effusion PCV/TS is supportive of ongoing, active intra-abdominal hemorrhage.
Lactate and BE
• High serum lactate (particularly, 5 mmol/L or greater) in combination with lower PCV and TS concentration is consistent with the need for transfusion[3]:
• BE values -6.6 or lower is supportive of transfusion needs. In canines with blunt trauma, arterial BE may serve as a predictor of mortality and blood transfusion requirements within 24 hours of admission.[12]
• Lactate and BE can be performed on most blood gas analyzers; either arterial or venous blood can be used to determine these values.
• Studies have shown the presence of cryptogenic shock in patients with elevated base excess (BE) or serum lactate level in face of systolic blood pressures at appropriate values.[15]
Diagnostic Imaging
• Survey radiographs in conjunction with a TFAST and AFAST, when available, are recommended diagnostic modalities to include during the primary survey to increase the diagnostic sensitivity of identifying internal hemorrhage. Additionally if available, computed tomography can be utilized as a more sensitive modality to determine extent of traumatic injuries and identification of occult hemorrhage. Clinicians should be aware of the need to not only acquire images in this modality but the need for interpretation of the data that is generated.

• Abdominal fluid score(AFS) in MWDs with traumatic hemoperitoneum:
  • AFS of 1 or 2 are considered small-volume bleeders, these patients rarely become anemic from the intraabdominal hemorrhage.
  • AFS of 3 or 4 are considered large-volume bleeders and are more likely to become anemic and warrant transfusion therapy.[16]

Table 7: Canine Vital Signs - Perfusion parameters based on severity of circulatory shock

Stage of shock	HR*	CRT	MM	Mentation	Pulse Quality	SBP
Normal *(at rest)**	< 120	< 2 s	Pink	Bright, alert	Strong	> 90
Acute Compensatory	> 120	< 1 s	Red	Normal	Fair	> 90
Early Decompensatory	> 140	> 2 s	Pale	Depressed	Weak	< 90
Terminal	< 80	absent	Pale	Obtunded	Absent	Low

**Normal values are for a RESTING state. Exercise/activity, pain, stress will result in higher HRs*

Table 8: Available blood products and indications for use

Product	Components	Indications
Fresh Whole Blood (FWB) *Use within 4 - 6 hours of collection*	• Red Blood cells (RBCs) and White Blood Cells (WBCs) • Plasma proteins[a] • All coagulation factors • Platelets	• Severe, acute hemorrhage • Anemia[c] + Hypovolemia • Anemia + Coagulopathy / ATC / TIC • Severe thrombocytopenia[d]
Stored Whole Blood (SWB) *Stored at 4°C for up to 28 days (depending on anticoagulant)*	• RBC, WBCs • Plasma proteins[a], coagulation factors, platelets (decreased circulation time)	• Severe, acute hemorrhage • Anemia + Hypovolemia • Anemia + Coagulopathy / ATC / TIC
Fresh Frozen Plasma (FFP) • *Frozen at < -18°C within 8 h from collection* • *Good for 1 year*	• All coagulation factors • Plasma proteins[a] • Antithrombin	• Coagulopathy / ATC / TIC • Colloidal volume resuscitation • Hemorrhagic shock as bridge to whole blood replacement
Freeze Dried Plasma (FDP) • *Lyophilized canine plasma* • *Reconstituted with water and then stable for 28 days refrigerated*	Essentially bioequivalent to FFP	• Coagulopathy / ATC / TIC • Colloid volume expander • Hemorrhagic shock as a bridge to whole blood replacement

[a] Plasma proteins include: albumin, globulin, and fibrinogen

[b] Consider **Acute Blood Loss/Hemorrhage** indicated if one or more of the following:
- Estimated or anticipated blood loss > 20% of eTBV, about 400 – 500 mL in a 25 kg MWD. (eTBV in MWD = 85 mL/kg)
- Systemic signs of hypoperfusion. (See Table 1.)
- SBP < 90 mm Hg or drop in SBP by ≥ 30 mm Hg
- Hypothermia (< 99°F or < 37°C)
- Hyperlactatemia (≥ 5 mmoL/L) and / or Base excess -6.6 or lower

[c] **Symptomatic anemia** resulting in:
- Tachycardia (HR ≥ 160 ± 20 beats/minute) ± bounding femoral pulses
- Pale to white mucous membranes
- Depressed mentation
- Presence of worsening anemia with signs of impaired oxygen delivery:
  - Hypoxemia (SpO_2 < 90%, room air)
  - Elevated RR (> 40 breaths/min) with increasing respiratory effort

ATC – Acute traumatic coagulopathy; **TIC** – Trauma-induced coagulopathy

Table 9: Indications for blood products use by condition

Indications	Recommended Component (In Order of Preference)
Anemia • Hypovolemia • Concurrent coagulopathy	Fresh or Stored Whole Blood
Severe, acute hemorrhage	1st: Fresh or Stored Whole Blood 2nd: pRBCs + FFP or (FDP) (1:1 or 1:2 ratio) 3rd : FDP or FFP as resuscitative fluid until whole blood can be administered
Thrombocytopenia (< 15,000) • Presence of spontaneous hemorrhage • Presence of petechial or ecchymosis	1st: Fresh whole blood 2nd: Stored whole blood
Coagulopathy • Idiopathic / inherited **ATC/TIC**	1st: Fresh Frozen Plasma or FDP 2nd: Whole Blood (consider patient volume status)

WHOLE BLOOD TRANSFUSION

Whole blood (WB) is the preferred product for resuscitation of severe hemorrhagic shock in an MWD. Canine WB contains a biologically balanced ratio of all canine blood products and, as such, is the product most likely to restore effective circulating volume and oxygen carrying capacity while preventing coagulation alterations. Any MWD that requires a transfusion subsequent to trauma-induced hemorrhage should receive WB as the product of choice when available.

The primary blood group classification of clinical significance for transfusion in MWDs is based on the dog erythrocyte antigen (DEA) system. Although approximately 13 antigen specificities have been identified, only the DEA 1 system (particularly DEA 1.1) is of most concern due to its high degree of antigenicity and ability to result in an acute hemolytic transfusion reaction. Naturally occurring anti-DEA 1 alloantibodies associated with acute hemolysis (< 24 hours post-transfusion) are not present in canines; therefore, a cross match prior to a MWD's first transfusion is generally not necessary in a naïve recipient.[17]

***Note**: Transfusion of DEA 1-positive blood to a DEA 1-negative MWD will cause the recipient to develop antibodies against the DEA 1 positive antigen; this places the MWD at risk for future transfusion reactions.*

To mitigate the risk of a potential transfusion reaction, the recipient's blood type and previous transfusion history should always be confirmed prior to any transfusion. A crossmatch compatibility should be done for any MWD that has received a previous transfusion ≥3 days prior to their next transfusion or if previous transfusion history cannot be confirmed. See below section on typing and cross matching.

HANDLING/STORAGE

- Fresh WB is collected from a donor and ideally administered to the recipient within 4-6 hours of collection.
- After 6-8 hours, the product becomes stored/chilled WB and should be kept at 4-6 degrees Celsius in a refrigeration device approved for chilled blood product storage.
- The shelf life of canine WB at 4-6 degrees Celsius depends on the anticoagulant used when the blood was collected.
- Canine WB should be stored refrigerated for up to 21 days when collected in CPD and up to 28 days when collected with CPDA-1. *(Note: the 28 day shelf life of canine whole blood is different than the shelf life of human whole blood based on currently available in vitro data on refrigerated canine whole blood.[2])*
- ***WB should never be left at room temperature for longer than 4-6 hours and should never be frozen***.
- When transporting canine WB, ensure that it is packaged in appropriate insulated containers on wet ice to maintain proper temperatures.

DOSAGE

- In most MWDs, a reasonable starting dose for a dogs needing a WB transfusion due to acute blood loss is one 450-500 mL bag (unit) of WB. Goal-directed clinical and laboratory reassessment of MWD should be done after the first bag of WB to determine if more blood is indicated.
  - A rough estimate of 2 ml/kg of WB is required to raise the patient PCV by 1%.
  - The desired target PCV to reach is one that results in sustained improvement of clinical signs and laboratory values for the MWD, usually >20-25%.
  - Simply targeting a normal PCV range may not be necessary and could result in increased risk for undesirable transfusion reactions.
- Transfusions that take longer than 4-6 hours to complete are at risk for bacterial contamination and subsequent adverse effects.
- In a controlled setting involving a hemodynamically stable MWD, start with an initial WB transfusion rate of 0.5 to 1 mL/kg/h for the first 15 minutes and monitor for any adverse transfusion reactions. If no transfusion reactions are observed, increase the rate to provide the remaining amount within 4 hours; recommended WB transfusion rates for normovolemic canines is 5 – 10 mL/kg/h.
- In emergent situations involving severe, acute blood loss leading to trauma-induced hemorrhagic shock, a goal-directed WB transfusion rate of up to 20 mL/kg/h or 1.5 mL/kg/min over 20 minutes can be administered to restore hemodynamic stability.
- Reassess the MWD after the first unit of WB to determine if a subsequent transfusion needed.

ADMINISTRATION

- When possible, chilled WB should be passively warmed to room temperature over 30-60 minutes prior to administration, or passed through an IV infusion line warmer during administration. A gravity drip with an in-line adult human 170-260 micron filter set is recommended for the administration of canine WB to an MWD unless a blood specific infusion pump is available; WB should not be run through a standard fluid pump in order to preserve the structure of the donor RBCs.[18,19]
- Administration to the MWD patient should occur through either a dedicated, large-bore (18 gauge or larger) peripheral or central intravenous catheter or an intraosseous catheter within a span of 4 hours. No other

fluid therapy or medication administration should occur simultaneously through the same catheter supporting a WB transfusion.

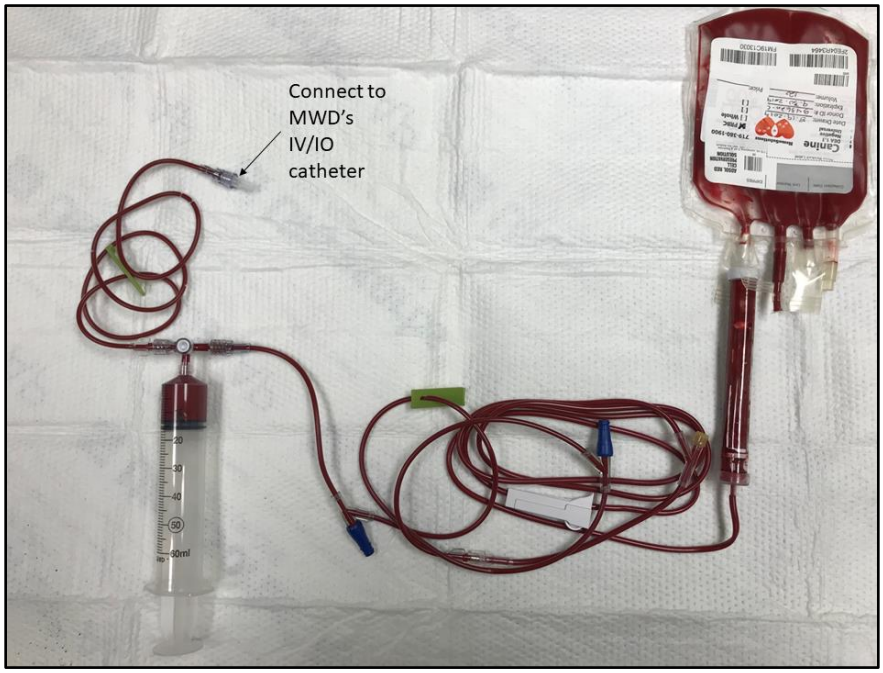
- Administration of WB by gravity flow is recommended in canines. In order to preserve the integrity of donor RBCs,[20] it is not recommended to administer WB through an infusion pump unless the pump and administration set are designed and validated for use with blood or other blood component (pRBCs, plasma, albumin, platelets).
- Transfusions that take longer than 4-6 hours to complete are at risk for bacterial contamination and subsequent adverse effects.
- In emergent situations, canine WB can be transfused rapidly to maintain effective circulating volume, oxygen carrying capacity and to prevent cardiovascular collapse. This can be accomplished by one of the below methods:

1. Manually squeezing the bag of whole blood or by placing the bag of whole blood in a pressure sleeve.

OR

2. Employ a rapid transfusion set (See Figure 1 below.)
    a. Spike the blood bag with a standard blood administration set.
    b. Connect a 3-way stopcock to the administration set and then connect a 60 mL syringe and an extension set to the 3 way stopcock.
    c. Pull blood from the bag into the 60 mL syringe and prime the line and the extension set.
    d. Ensure any air is removed from the circuit and connect the extension set to the MWD's catheter.
    e. WB can then be rapidly pushed from the syringe to the MWD and refilled from the bag without disconnecting the set.

Figure 1. Example of WB set up for rapid infusion



Transfusion monitoring and reassessment

1. Measure and record baseline values of vital signs and perfusion parameters prior to the start of the transfusion. Values to measure include: rectal temperature, heart rate, pulse rate and quality, respiratory rate, mucous membrane color, capillary refill time, and blood pressure (if equipment is available).
2. Reassess vital signs:
    a. Every 5 minutes for the first 15 minutes, then
    b. Every 15 minutes for the first hour, then
    c. Every 30-60 minutes until completion of the transfusion.
3. Capture a final set of vital signs at the conclusion of the transfusion.
4. Re-evaluate a PCV and TS one to two-hour post-transfusion.

Transfusion reactions

- Transfusion reactions of concern with canine WB transfusions include acute hemolysis, allergic/anaphylactic hypersensitivity, febrile non-hemolytic, and delayed hemolysis. (See Table 10 below.)
- Supportive treatment should address the type and severity of the reaction, but in all cases the transfusion should be stopped immediately to allow for further assessment of the patient and donor bag before continuing.
- For mild reactions, decreasing the transfusion rate (typically decrease the rate by 50%) may be all that is needed to avoid further issues. If signs of transfusion reaction persist or worsen, the transfusion should be halted and the supporting 64F should be consulted.

***Note**: A 64F is a veterinary clinical specialist typically found at the veterinary unit co-located with the human Role 3 and higher facilities. A 64F can also be reached via the ADVISOR Trauma Care Helpline, Option #5.*

Table 10. Transfusion reactions[19]

Transfusion Reaction	Clinical Signs
Acute Hemolytic Reaction Result of recipient immunological reaction to donor red cell antigens	• Fever • Weakness, tremors • Salivation, vomiting and/or elimination • Agitation, vocalization • Tachycardia, arrhythmias • Tachypnea, dyspnea • Hypotension • Hemoglobinemia • Hemoglobinuria
Delayed Hemolytic Reaction Result of recipient immunological reaction to donor cell antigens	• Clinically less severe Acute Hemolytic Reaction • Occurs >2 days post-transfusion

Transfusion Reaction	Clinical Signs
Febrile, Non-Hemolytic Reaction Result of white cell antigens and other bioactive substances in donor blood	• Temperature increase of >1° Celsius (~2°Fahrenheiht) • Vomiting • Tremors • Resolution in 1 to 12 hours
Hypersensitivity Transfusion Reaction Result of recipient IgE-mediated reactions to donor gamma globulins	• Mild to severe urticaria • Mild to severe angioedema and erythema • Anaphylaxis, bronchoconstriction and effusions in severe cases • Typically no fever expected • Can occur within minutes to hours of starting
Pre-Transfusion Hemolysis Result of improper storage or handling of donor blood, or bacterial contamination	• Signs will mimic Acute Hemolytic Reaction
Transfusion Related Circulatory Overload (TACO) Related to large volume and massive transfusions	• Hypocalcemia from citrate intoxication • Tremors and seizures • Arrhythmias • Dilution thrombocytopenia or coagulopathy • Hypomagnesemia • Acid-base disturbances • Hypothermia
Transfusion-Related Acute Lung Injury (TRALI) Rare in canines	• Tachypnea, tachycardia and respiratory distress related to development of non-cardiogenic pulmonary edema

FRESH FROZEN PLASMA TRANSFUSIONS

Canine FFP is canine WB that is separated from its cellular components and frozen within 8 hours of collection. FFP can be stored frozen for up to one year which then is relabeled as frozen plasma (FP). FFP contains all coagulation factors and plasma proteins found in circulating blood. FP contains most of the coagulation factors but loses the labile factors (FV, FVIII, von Willebrand factor) over time.

USES

- FFP is indicated to correct coagulation factor deficiencies and or prophylactically to treat MWDs who are at risk of bleeding from clotting factor abnormalities.
- As compared to isotonic crystalloids, canine FFP provides the following added benefits as a resuscitation fluid:

- Supports hemostatic resuscitation. Its ability to deliver coagulation factors and other plasma proteins (e.g. albumin, fibrinogen) while restoring intravascular volume minimizes the risk of invoking a dilutional coagulopathy.
- Provides oncotic support by supplementing albumin in addition to restoring effective circulating volume.

AVAILABILITY

- FFP comes in different sized units but 240 to 250 mL units are most appropriate for MWDs.
- FFP is obtainable from one of two methods:
  1. Separation of Fresh Whole Blood (FWB):
     - Place a unit (450 to 500 mL) of FWB into a blood centrifuge and spin at 2000 x g for 10 minutes to separate the cellular components.
     - Express the plasma from the primary collection bag into a satellite bag and then seal.
     - Place plasma in freezer at -20°C to -80°C (-4°F to -112°F) within 8 hours of collection if it is intended to serve as FFP.
  2. Plasmapheresis is an alternate way to obtain FFP; however, this process requires special training and equipment. Only trained personnel with the appropriate equipment should perform plasmapheresis.

HANDLING/STORAGE

- FFP should be stored in a dedicated, appropriate freezer at -20 to -80°C. Perform daily temperature checks to ensure the freezer is secured and operating appropriately.
- If FFP is to be shipped it should be shipped with proper insulated packaging on dry ice to ensure the product remains frozen at the correct temperatures.

***Note**: Care should be taken when handling FFP as the plasma bag is not pliable and can crack at low temperatures. Consider placing in two large Ziploc® bags or similar packaging to avoid direct handling of the FFP bag.*

DOSAGE AND ADMINISTRATION

- Typical dose of canine FFP is 10 to 20 mL/kg over 1- 4 hours (depending on the situation). This translates to approximately one to two 240 to 250 mL bags of FFP per MWD.
- FFP should NOT be used to try to increase plasma albumin levels as up to 40 to 50 mL/kg could be necessary to raise recipient's albumin levels by 1.0 g/dL.
- MWDs that do not have ongoing hemorrhage or other substantial fluid losses, administration of FFP over 2-4 hours is appropriate.
- FFP must first be thawed before administration.
  - Optimally, thaw FFP in a commercial plasma thawer following manufacturer's recommendations for thawing human plasma.
  - If no plasma thawer is available, remove FFP from the freezer and place in two Ziploc® bags. Submerge the FFP and outer Ziploc® bags in lukewarm tap water. A large MWD food bowl is often suitable for this purpose.

- Ensure the water does not exceed 98.6°F (37°C); water temperatures exceeding 98.6°F (37°C) may cause protein denaturation. It is important that the thawing process does not occur too quickly by adding hot water as plasma proteins can be denatured if the process is rushed. Consider exchanging the water every 15 to 20 minutes or use a gentle continuous flow of water if necessary to keep the water bath warm. Expect 30-40 minutes to complete the thawing process using this technique.
- Once thawed, spike FFP bag with a blood administration set (which contains a 170 micron blood filter) or a regular fluid administration set. If no blood administration set is available, place a blood filter (Hemo-Nate® filter) in the transfusion line to reduce transfusion of clots or other impurities from the transfused product. Do not let the lack of a Hemo-Nate® (or similar blood filter) preclude the administration of FFP if it is clinically necessary.
    1. Connect the primed transfusion line to a 20 gauge or larger bore peripheral or central IV catheter or an IO catheter.
    2. Begin transfusion at 1 to 2 mL/kg/h over the first 15 minutes and monitor the MWD for signs of transfusion reaction. (See Table 10.) If there is no significant reaction, increase the rate of transfusion to 2 to 4 mL/kg/h for an additional 15 minutes. If no transfusion reactions are seen over the first 30 minutes, increase the transfusion rate to ensure the complete delivery of FFP within 2 to 4 hours.

- In emergent situations, consider blousing 1-3 units thawed FFP to MWDs similar to that indicated for MWDs that are rapidly losing blood form a major blood vessel laceration. Bolus the whole unit of FFP over 10 minutes by one of the following techniques:
    - Placing the FFP bag in a commercial IV pressure infuser system or manual squeezing of the FFP bag, OR
    - Using the 3-way stopcock and 60 mL syringe set-up described in the WB administration section above.

Transfusion monitoring and reassessment

- Vigilant monitoring for transfusion reactions is required during non-emergent FFP transfusions (e.g. in absence of bolus FFP therapy). Types and signs associated with transfusion reactions are similar to those for WB transfusions. (See above section on transfusion reactions for WB.)
- Monitor core body temperature, pulse rate and quality, respiration (rate and effort) and blood pressure:
    - Every 5 minutes for the first 15 minutes of transfusion, then
    - Every 15 minutes for the first hour, then
    - Every 30-60 minutes thereafter until completion of the transfusion.
- The most common indications of a transfusion reaction are fever, facial edema, tachycardia, tachypnea, vomiting, hypotension and weakness.[7]
    - If any of these signs are encountered, reduce the transfusion rate by 50% and reassess the MWD. If clinical signs resolve, continue the transfusion.
    - If signs of transfusion reaction persist or worsen despite reducing the transfusion rate, halt the transfusion and seek consultation with the supporting 64F.
- Reassess the MWD upon completion of the transfusion. Assessment includes a physical examination with special attention to the cardiovascular, coagulation and perfusion parameters to include blood pressure assessment. If end points of resuscitation are not reached, consider administering an additional unit of FFP following the guidelines above.

- Continue hemorrhagic shock resuscitation with FDP or FFP until canine WB is available to administer.

FREEZE DRIED PLASMA

Canine Freeze Dried Plasma (cFDP) can be used in lieu of FFP for any of the above-mentioned indications cited for FFP. In addition, since cFDP can be reconstituted quickly (does not require a thawing process), it is possible to start a transfusion more rapidly as compared to FFP. When available, strongly consider cFDP as a resuscitation product at the point of injury, en route to Role 2 or 3 care and/or until canine WB becomes available. cFDP replaces effective circulating volume without diluting coagulation factors or substantially reducing oncotic pressure. In this way, cFDP's most beneficial role on the battlefield is to serve as bridge to resuscitation with canine WB. Evidence supports that cFDP is biologically equivalent to FFP in terms of coagulation factor activity, biochemical profile and clot forming ability (Edwards – unpublished data).

HANDLING/STORAGE

- cFDP is available as a white to yellow powdered product within a transfusion bag that is enclosed in a Mylar outer wrap. To minimize any transfer of moisture from the environment into the product, do not open the Mylar wrap until the product is ready for use.
- Store cFDP at room temperature or refrigerated at 2 to 6°C (35.6 to 39.2°F).

RECONSTITUTION

Follow the manufacturer's directions in the reconstitution of cFDP. In general, sterile water for injection (amount specified by the manufacturer) is aseptically added through either an inserted port or the designated port provided on the bag of cFDP. Gently manually mix the bag until the product completely dissolves (approximately 5 minutes). Once reconstituted, either transfuse within 4 hours of reconstitution or refrigerate for up to 28 days.

DOSAGE

- MWDs in need of a plasma transfusion should typically receive one 240 to 250 mL bag (unit) of cFDP; reassess after the first unit to determine if the MWD requires subsequent transfusions.
- The speed of administration depends on the indication and clinical condition of the MWD.
    - For MWDs that do not have ongoing hemorrhage or other substantial fluid losses, administration of FDP over 2 to 4 hours is typically appropriate.
    - In emergent situations, bolus FDP as indicated for MWDs that are rapidly losing blood. Boluses of 1-3 units may be necessary to stabilize a severely injured MWD. To accomplish this, a unit of FDP may be placed in a commercial pressure infuser sleeve or can be accomplished by using the 3 way stopcock and 60 mL syringe set up described in the WB administration section above.

ADMINISTRATION

- If the bag of FDP has an inline filter, attach extension sets to the inline filter port and prime the line with FDP to remove the air. If no inline filter is present, spike the bag of FDP with either a:
  - Blood administration set (that contains a blood filter), OR
  - Regular fluid administration set that has a separate blood filter (such as a Hemo-Nate® filter) placed in the transfusion line.

  ***Note**: Although an in-line filter is recommended to reduce clots or other impurities from the transfused product, the lack of a blood filter does not preclude the administration of FDP if the transfusion is clinically necessary.*

- Connect the primed transfusion line to a 20-gauge or larger peripheral or central IV catheter or an IO catheter.
- Begin transfusion at 1 to 2 mL/kg/h over the first 15 minutes and monitor for signs of transfusion reaction (see below). If no significant reaction observed, increased the rate of transfusion to 2 to 4 mL/kg/h for an additional 15 minutes. If no transfusion reactions observed over the first 30 minutes, increase the transfusion rate to ensure delivery of the FDP unit is complete within 2 to 4 hours.

TRANSFUSION MONITORING AND REASSESSMENT

Transfusion monitoring and assessment in the administration of FDP is the same as for FFP detailed above.

BLOOD DONATIONS (WALKING BLOOD BANKS)

When canine WB is not available and is needed for a critically injured or ill MWD, blood can be collected from other canines for donation. U.S.-based MWDs are the recommended first-choice for walking-blood donors, since the U.S. Army Veterinary Corps knows that these canines are well-cared for, healthy, up-to-date on all major vaccinations and preventative medications, and clear of blood-borne infectious diseases. If a U.S.-based MWD is not available, consider a US based contract working dog as an alternative donor. Due to the high risk of disease transmission, NEVER use an indigenous canine as a blood donor. An ideal MWD to select for further screening is a canine that has never received a prior transfusion of any blood product (to include plasma products), weighs over 60 pounds (27 kg), are deemed healthy (based on physical examination), and not receiving any medication other than standard preventive medications (heartworm, flea and tick).

SCREENING[21]

- If not previously known or performed, use a commercial DEA-1 blood-type kit to determine the blood type of the potential MWDs (see below section on typing and cross matching).
- Screen ALL canines for infectious diseases caused by Dirofilaria immitis, Borrelia burgdorferi, Ehrlichia canis, Ehrlichia ewingii, Anaplasma phagocytophilum, Anaplasma platys, Leishmania utilizing in-house diagnostic tests.
- Obtain a minimum database (complete blood count, serum chemistry profile, urinalysis, and fecal floatation) to assure that no underlying conditions are present that precludes donation.

- MWDs that are negative for infectious diseases and have no significant abnormalities noted on their minimum database are considered acceptable donors unless other extenuating circumstances deem the donor not acceptable.

***Note**: In an emergent situation when time is critical, it is reasonable to consider any healthy MWD as a blood donor even if they have not had the aforementioned screenings.*

BLOOD COLLECTION

- Do not collect blood from donors more frequently than every two months.
- Do not work or fly (via fixed wing aircraft) a donor for 24 hours following a donation to allow recovery from donation.
- Consider administering intravenous isotonic crystalloids to a donor following blood collection as needed to replace the volume donated.

Anticoagulants.

Recommend the use of CPDA-1 (citrate phosphate dextrose adenine). CPDA-1 results in the longest blood shelf life at 28 days for canine WB. If CPDA-1 is not available, collect WB into bags containing CPD.

***Note**: Canine WB anticoagulated with CPD results in a recommended shelf-life of up to 21 days when properly stored at 6°C (+/- 2°C). Approximately 1 mL of anticoagulant is used per 9 mL of blood collected from a dog*.
Caution**: **Accidental intravenous injection of undiluted citrate anticoagulants may cause cardiac arrest.

Sedation

- Always take the MWD's temperament into consideration prior to administering any sedatives. Although most MWDs require sedation in order to keep them still to facilitate blood collection, not all MWDs require the same levels of sedation.
- For most MWDs, consider the following initial protocol:
  - Butorphanol (0.1 – 0.4 mg/kg IV/IM) combined with,
  - Midazolam (0.25 – 0.5 mg/kg IV/IM).

  If butorphanol is not available consider hydromorphone (0.05-0.1 mg/kg) IV/IM combined with Midazolam

  Considering the average size MWD weighs approximately 30 kg, consider the following doses as acceptable for initial sedation in situations when a MWD's weight is unknown and/or not obtainable:

  - Butorphanol (3 to 12 mg IV/IM) OR hydromorphone 1.5-3 mg IV/IM combined with,
  - Midazolam (8 to 15 mg IV/IM).

***Note**: Most MWD Handlers have a weight-based MWD drug card that includes drugs doses that are specific to their MWD. Check for this card prior to making any weight-based drug calculations.*

  - Some MWDs may require heavier sedation to facilitate blood collection and avoid complications such as damage to the blood vessel (aka. blown vein) leading to contamination and/or insufficient collection. For these cases, consider adding ketamine (2 to 4 mg/kg IV/IM) to the above listed protocol.
  - AVOID the following drugs in the sedation protocol:

1. Acepromazine: May influence platelet function; therefore, is not recommended in situations that warrants active platelets.

2. Dexmedetomidine: May causes clinically significant bradycardia and peripheral vasoconstriction, which interferes/hinders blood flow and collection.

Procedure

- Employ aseptic technique
  1. Wash hands with soap and water prior to the procedure and don sterile gloves.
  2. Clip and surgically prepare the area over the external jugular vein.
- Do not allow air to enter the blood collections system. Most commercial blood collections systems designed for humans possess an in-line device that prevents air from entering the line. If not using a human-designed commercial blood collection system, consider the following to prevent air from entering the system.
  1. Clear the collection line of air by turning the bag upside down, removing the needle cover and allowing a few drops of anticoagulant to exit the needle.
  2. The collection line is then immediately clamped and not released until the venipuncture has been accomplished.
- Using a standard human tri or quad commercial blood donation bag set, sterilely insert the attached needle into the left or right external jugular vein. Once inserted, the in-line cannula is broken to allow the flow of blood to begin.
- Utilize a balance or gram scale for collection. Prior to collection, tare the scale with the collection bag to "Zero".
- Blood is collected by gravity flow into a standard 500 mL CPD or CPDA-1 blood bag to the appropriate volume.
  1. Place the MWD in lateral or sternal recumbency. If the MWD is in lateral recumbency, place a towel underneath the neck in order to facilitate obtaining and preserve venipuncture of the jugular vein.
  2. Place the collection bag on the floor or at a location lower than the MWD.
- Ensure the ratio of blood collected to anticoagulant is exact to assure an appropriate level of anticoagulation as well as to maximize cell viability:

  The specific ratio is 450 mL blood +/- 10% (i.e. 405 mL to 495 mL) per 63 mL of anticoagulant (CPD or CPDA-1).
- Gently rock the bag during collection to insure adequate mixing of the blood and anticoagulant.
- Discontinue collection when the total weight of the blood collected is 430 to 450 grams.
- At the end of collection:
  1. Clamp or tie off the line before removing the needle from the vein; this prevents air from entering the bag before all the blood has cleared the walls of the line.
  2. Remove the needle from the vein and apply appropriate pressure to the venipuncture site for at least 5 minutes to prevent further bleeding.

- After the collection line is tied or clamped, use a tube stripper to "strip" the blood left in the line into the bag.
    1. Gently rotate the bag to mix the blood and anticoagulant;
    2. Invert the bag and allow the line to refill.
    3. Repeat four to five times to assure thorough mixing of the blood in the line with the anticoagulant in the bag.
- When collecting WB, satellite bags should be removed using heat sealers or clamps leaving only the collection bag containing WB.
    1. The line is then heat sealed, clamped or tied in segments for use in future cross-matches.

    ***Note**: The line has a series of numbers printed on the surface that correspond to segments. Fill the line, then use the heat sealer to separate it into appropriate segments (approximately 6 to 8 segments) or 'pigtails'. These "pigtails" are used for cross-matching.*

    2. Heat seal the line then cut the needle from line and discard the needle according to safety procedures.
- Mark the outside of the bags with: collection date, donor's name, weight of the bag, and PCV of the donor. Make three labels – one for the transfusion sheet, one to remove and place in the inventory log book, and one to stay on the bag.
- Store fresh WB upright in a designated refrigerator, with a temperature record maintained daily and recorded on the outside of the refrigerator.

Table 11. Supplies needed for MWD blood donation

Donor Screening Supplies	Sedation Supplies (If Needed)	Collection Supplies
• Syringes, needles, and tubes for blood and urine collection • Leishmania tests –(if in endemic area) (NSN 6640-NCM093803) • Idexx SNAP 4Dx Plus tests (NSN 6550-016504412) • Canine blood typing cards - Rapid Vet (NSN 6550-016479167) • CBC, Chemistry, UA, and Fecalyzer	• Atropine sulfate • Butorphanol • +/- Midazolam +/- ketamine • Syringes, needles, calculator	• 4x4 gauze sponges • Sterile scissors • Sterile draping cloth • Sterile gloves • Whole Blood Collection Bags (CPD or CPDA-1) • Balance or gram scale • Strippers • Metal clamps or heat sealer
Supportive Care Supplies	**Aseptic Prep Supplies**	**Crossmatch Supplies (Optional)**
• 18 G IV Catheter supplies • Crystalloid fluids 1 liter (x 2) • Primary IV set • Pressure infusion bag or fluid pump • Vitals Monitor	• Clippers • Rolled towel to support neck • Exam Gloves • Chlorhexidine or betadine surgical scrub • Sterile gauze • Sterile saline or Alcohol	• 0.9% saline • 3 mL test tubes • Pipettes • Centrifuge • Agglutination viewer lamp (optional, microscope also works)

TYPING/CROSSMATCHING OF MWDS

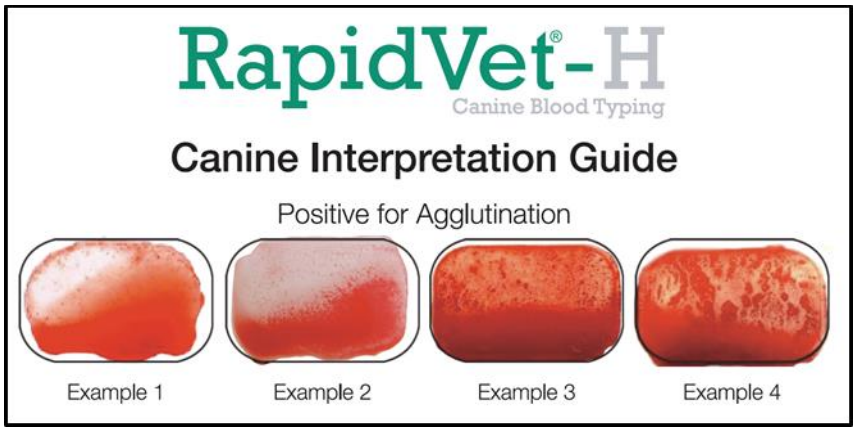
MWDs or other CWDs operating in a deployed environment may or may not have their blood type identified prior to deployment. Identification of a canine's blood type during deployment and prior to transfusion is always recommended but might not be possible unless commercially available blood typing kits (See Figure 2.) are fielded at a Role 2 or Role 3 Veterinary Facilities. For reasons explained below, naïve canines that have never received a prior blood product transfusion can safely receive blood transfusions for a short period of time prior to both typing and cross-matching, if necessary.

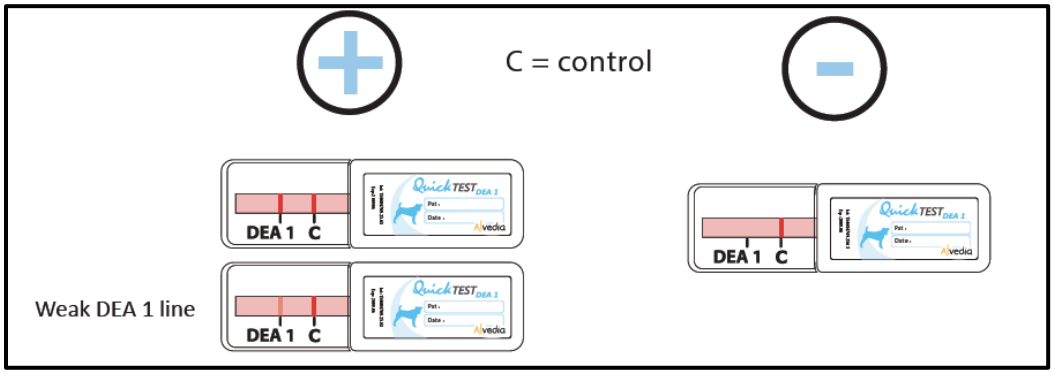
The most commonly tested and reported blood type in canines is DEA 1. In addition to DEA 1, there are 12 other DEA blood types that are based on antigenic surface markers of the canine erythrocyte.[22] Generally speaking, only the presence of the DEA 1 antigen has historically resulted in clinically relevant transfusion reactions in dogs. As a result, most commercially available blood typing kits screen specifically for the presence (DEA 1 positive) or absence (DEA 1 negative) of the DEA 1 antigen. MWDs and other operational canines will therefore have a blood type reported as DEA 1(or with the older naming convention DEA 1.1) positive or negative if they have been previously blood typed. Although DEAs could theoretically cause transfusion reactions, there is no evidence in the veterinary literature to support routine screening of these antigens.

It is important to note that canines do not typically have naturally circulating alloantibodies to the DEA 1 antigen. Therefore, it is possible to transfuse non-typed canine blood products into another MWD and not experience a transfusion reaction – giving rise to the adage that "the first transfusion is free." In practice, the veterinary personnel and other HCPs in theater can emergently provide blood products to MWDs without knowing the blood type of the MWD during the first 72 to 96 hours of care. However, dogs will develop alloantibodies to the DEA antigens 5 to 7 days post-transfusion and should be cross-matched 72 hours after receiving the first transfusion.

Popular, commercially available blood typing kits include point-of-care kits made by RapidVet® and Alvedia (Figure 2). Both kits are simple, inexpensive, and easy-to-use. However, the user should be advised that erythrocyte auto-agglutination can affect interpretation of the RapidVet® test kit. If erythrocyte agglutination is present, a cell washing step is required prior to using the typing cards. The Alvedia test kit is unaffected by cell agglutination due to its patented membrane technology embedded in the testing cartridges.

Figure 2. Examples of Common Blood Typing Kits.





All MWDs should be cross-matched if 72 hours have elapsed since its first transfusion or if any previous transfusion resulted in a transfusion reaction. Crossmatching is the process by which donor and recipient blood are assessed for compatibility and thus reduces the likelihood of a transfusion reaction.

There are two types of cross-matching: **Major** and **Minor.**

1. **Major Crossmatch:** Recipient's serum is mixed with a suspension of the donor's red blood cells. A major crossmatch detects antibodies present in the recipient's serum that will react to antigens present on the donor red blood cells.

2. **Minor Crossmatch**: Recipient's red blood cells are mixed into the donor's serum. A minor crossmatch detects antibodies present in the donor's serum that will react to antigens present on the recipient's red blood cells.

Performing a cross-match is accomplished using either a/an:

1. Commercial cross-matching test kit:

   RapidVet® provides a testing kit called the RapidVet®-H Companion Animal Crossmatch Test for both major and minor crossmatching. The procedure involved in this kit is very similar to traditional laboratory based crossmatching and personnel should refer to manufacturer's directions for the proper employment of the test kit. The advantage in using the RapidVet® kits is that the gel-impregnated kits

used to do the final assessment prevent artifact if naturally occurring red blood cell auto-agglutination is present.

2. In-house, field-expedient procedure described below in Table 12. Equipment required:
   - Small centrifuge
   - Image result for Ethylenediaminetetraacetic acid (EDTA)
   - EDTA-impregnated blood collection tubes (purple top)
   - Non-serum separator blood collection tubes (red top)

Table 12. Field-Expedient Crossmatch Procedure.[23]

Field-Expedient Crossmatch Procedure	
1	Collect EDTA (purple top) blood samples from both the donor and recipient dog.
2	Centrifuge at 5000 x G for 5 minutes
3	Separate plasma from the purple top tubes and decant into red top tubes labeled “plasma.”
4	Place remaining suspension of RBCs in red top tubes labeled “RBCs.”
5	Fill RBC tubes with 2.5 mL sterile saline. Mix gently and centrifuge for 1 min @ 5000 x G.
6	Decant saline and repeat process 3 times to wash the cells of proteinaceous debris.
7	Resuspend RBC pellet with 2.5 mL of saline.
8	**Major Crossmatch**: 2 drops of plasma from recipient placed into a new red top tube with 1 drop of RBC solution from the donor.
9	**Minor Crossmatch**: 2 drops of plasma from donor dog placed into new red top tube with 1 drop of RBC solution from recipient.
10	**Recipient Control**: 2 drops of recipient plasma with 1 drop of recipient RBC solution in new red top tube.
11	All solutions are mixed gently and incubated for 20 min @ 37C.
12	Centrifuge solutions for 15 seconds.
13	Inspect tubes for macroscopic appearance of cell agglutination. Presence in either of the crossmatch solutions indicates incompatibility. Presence in the control tube indicates auto-agglutination and voids any further interpretation of cross-matching results with this procedure.
14	Place one drop on a slide with coverslip and inspect for microagglutination. If present, add a single drop of saline to confirm agglutination. Score agglutination as follows: 4+ = Single solid clump of cells 3+ = Several solid clumps of cells 2+ = Multiple small clumps of cells with cell/debris-free background 1+ = Hemolysis with no visible agglutination. NEG = No hemolysis or agglutination present.
15	Blood is deemed fully compatible with NEG results. However, in practice 1+ agglutination score is generally compatible and safe for a transfusion.

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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Traumatic Brain Injury Management in Prolonged Field Care (CPG ID: 63)

This CPG provide medical professionals who encounter traumatic brain injury (TBI) in austere environments with evidence-based guidance.

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INTRODUCTION

This Role 1, prolonged field care (PFC) guideline is intended to be used after Tactical Combat Casualty Care (TCCC) Guidelines when evacuation to a higher level of care is not immediately possible. A provider of PFC must first be an expert in TCCC. This clinical practice guideline (CPG) is meant to provide medical professionals who encounter traumatic brain injury (TBI) in austere environments with evidence-based guidance. Recommendations follow a "best, better, minimum" format that provides alternate or improvised methods when optimal hospital options are unavailable. A more comprehensive guideline for TBI management is available in the Joint Trauma System Clinical Practice Guideline for Neurosurgery and Severe Head Injury at https://jts.health.mil/index.cfm/PI_CPGs/cpgs.

TBI occurs when external mechanical forces impact the head and cause an acceleration/deceleration of the brain within the cranial vault which results in injury to brain tissue. TBI may be closed (blunt or blast trauma) or open (penetrating trauma).[1] Signs and symptoms of TBI are highly variable and depend on the specific areas of the brain affected and the injury severity. Alteration in consciousness and focal neurologic deficits are common. Various forms of intracranial hemorrhage (ICH), such as epidural hematoma, subdural hematoma, subarachnoid hemorrhage, and hemorrhagic contusion can be components of TBI. The vast majority of TBIs are categorized as mild and are not considered life threatening; however, it is important to recognize this injury because if a patient is exposed to a second head injury while still recovering from a mild TBI, they are at risk for increased long-term cognitive effects. Moderate and severe TBIs are life-threatening injuries.

Prompt evaluation and intervention are necessary to reduce disability and mortality. Rapid evacuation and neurosurgical evaluation, while desirable, are not always feasible in austere environments. Nevertheless, recent data from the conflicts in Iraq and Afghanistan have shown improved mortality among military TBI casualties when compared with similar, propensity score–matched civilian TBIs. This is due partly to the aggressive resuscitation that began at the point of injury.[2] PFC providers, therefore, should be prepared to use resources at hand for aggressive medical management in these patients until additional medical and surgical assets can be made available.

Regardless of mechanism, two categories of injury occur with TBI: primary and secondary. Primary injury occurs at the time of injury and results in irreversible damage to brain tissue.

There are no effective treatments for primary injury. Secondary injury, in contrast, occurs as a result of a complex inflammatory cascade that results in rapid development of brain swelling, rise in intracranial pressure, and subsequent decrease in cerebral perfusion. When severe, this can lead to massive swelling, compression of the brainstem, and, ultimately, death. Thus, the primary focus of TBI management is on limiting the effects of secondary brain injury. The brain possesses minimal cellular oxygen reserve and, therefore, is highly dependent on a continuous supply of oxygenated blood. A systolic blood pressure (SBP) <90mmHg or oxygen saturation via pulse oximetry (SpO_2) <90% more than doubles the risk of death from brain injury.[3] The management of hypotension, hypoxia, hypocarbia or hypercarbia, hypoglycemia, and signs of elevated intracranial pressure (ICP) is essential.

Telemedicine – Management of TBI is complex. Establish a telemedicine consultation as soon as possible.

NEUROLOGIC ASSESSMENT

Goal: Rapidly identify the clinical signs and symptoms of TBI and associated traumatic injuries and assess TBI severity.

Track the progression of brain injury over time and be vigilant for the early signs of rising ICP: worsening headache, focal neurologic deficits and declining neurologic examination.

- **Primary survey**: Perform a rapid trauma survey to assess all injuries. Determine and record the Glasgow Coma Scale (GCS) score (Table 1 below). Assess pupils and motor function in all four extremities.
- **Secondary survey**: After stabilizing any immediate life-threatening injuries, assess for TBI red flags that may indicate moderate to severe head injury (Table 2 below), and perform an initial detailed neurologic examination. See Appendix A for further details on performing a neurologic examination. Annotate findings on the PFC flowsheet.
- **TBI severity classification** using the GCS score[4]:
  - Mild: 13–15
  - Moderate: 9–12
  - Severe: 3–8

Table 1. *Glasgow Coma Scale*

Eye Opening	Verbal Response	Motor Response
4 – Spontaneous 3 – To verbal command 2 – To painful stimuli 1 – No response	5 – Oriented 4 – Confused 3 – Inappropriate words 2 – Incomprehensible sounds 1 – No response	6 – Obeys commands 5 – Localizes to painful stimuli 4 – Withdraws from pain 3 – Flexion to pain 2 – Extension to pain 1 – No response

Table 2. *Features Indicative of Moderate to Severe Head Injury*

Red Flags
Witnessed loss of consciousness
Two or more blast exposures within 72 hours
Unusual behavior or combative
Unequal pupils
Seizures
Repeated vomiting
Double vision or loss of vision
Worsening headache
Weakness on one side of the body
Cannot recognize people or disoriented to place
Abnormal speech

Neurologic Assessment Note

An emerging technology that can be considered as an adjunct to neurologic assessment is ultrasound measurement of optic nerve sheath diameter (ONSD). If the patient is unconscious (i.e. does not follow commands or open eyes spontaneously), measure a baseline ONSD. There is no definite diameter that is diagnostic of increased ICP; however, an ONSD >5.2mm, especially if it increases over time, may indicate elevated ICP.[5] In no circumstance should measurement of ONSD take priority over a neurologic examination, and all results must be considered in the context of the neurologic examination and overall patient status. See Appendix B for further details on using ultrasound to obtain and interpret ONSDs.

ONSD should NOT be attempted in any patient who has sustained an open globe injury where any pressure on the globe is contraindicated. As many as 30% of head injuries in combat may also have an eye injury.[6]

MONITORING

Goal: Prevent secondary brain injury by maintaining adequate oxygenation and ventilation, avoiding hypotension, observing for signs and symptoms of elevated ICP, and trending the response to resuscitation. Detect changes in vital signs and neurologic examination as early as possible.

- **Minimum**: Blood pressure cuff, stethoscope, pulse oximeter, method to monitor urine output. If an advanced airway is in place, monitor $EtCO_2$ with capnometer. Check pupillary response and GCS as often as possible. Document vital signs, GCS score, and urine output on the PFC Casualty Card available at https://prolongedfieldcare.org.
- **Best**: Portable monitor providing continuous vital-signs display, Foley catheter to monitor urine output. If an advanced airway is in place, monitor end-tidal carbon dioxide ($EtCO_2$) with capnography. Check pupillary response and GCS score every hour. Document vital signs, GCS, and urine output on the PFC Casualty Card available at https://prolongedfieldcare.org.

ASSESSMENT AND MONITORING NOTES

- Perform an initial assessment according to TCCC/MARCH (Massive hemorrhage, Airway, Respirations, Circulation, Head injury/Hypothermia) algorithms.
- Severe head injury is associated with additional trauma in 60% of patients.[7]
- If ONSD is used to evaluate for increased ICP and response of ICP to interventions, repeated ultrasound examinations should be performed if there is any change in neurologic examination and at regular intervals (30 minutes) after performing ICP-lowering interventions.
- When possible, a pocket ophthalmoscope can be used to assess for the presence or absence of spontaneous venous pulsations (SVPs). SVPs are only present when ICP is normal. Visualization of SVPs can reassure the provider that ICP is not critically elevated.[8] See Appendix C for additional information on the rapid assessment of SVPs.
- Consider early C-spine immobilization. The incidence of concomitant brain and spinal cord injury in trauma ranges from 25% to 60%, with motor vehicle crashes and falls having the highest incidence of co-occurence.[9] Ensure the cervical collar does not compress the jugular veins in the neck, because that could worsen ICP.
- The neurologic examination is essential to identify deterioration in a TBI patient. Treat for elevated ICP for any deterioration in neurologic examination findings.
- Pain medication and sedation are usually required for TBI patients; however, these medications also make it difficult to follow the neurologic examination.
- Obtain a telemedicine consultation if possible. If in doubt, treat for elevated ICP according to ICP management outlined in the next section.
- Close control of $EtCO_2$ is critical for severe TBI patients. Plan and ensure the capability to monitor $EtCO_2$ is available whenever advanced airway is placed. Goal $EtCO_2$ is 35–40mmHg.

Cushing's triad (i.e., increased SBP and/or widening pulse pressure, bradycardia, and irregular respirations) is a physiologic response that can occur with elevated ICPs, resulting in medullary compression. It is a late finding of severe brain injury with brainstem herniation. Cushing's triad should be viewed as a sign of cerebral herniation and addressed immediately when recognized (see ICP Management).

MANAGEMENT

HEMODYNAMIC CONTROL

Goal: Maintain SBP >110mmHg. In polytrauma patients with ongoing bleeding, aggressively control hemorrhage using all means available and restore circulating blood volume by using blood products.
***Note**: An SBP >90mmHg has traditionally been targeted in TBI patients, though recent literature has suggested better outcomes may occur when SBP is maintained above 110mmHg in TBI patients*.[10,11]

- **Minimum**: Stop all external bleeding. Manage internal bleeding to the extent possible with available resources. Administer tranexamic acid (TXA) per TCCC guidelines. Avoid medications that may lower the blood pressure (e.g., narcotics).
- **Better**: If there is evidence of bleeding and no blood products are available, administer 1L 0.9% sodium chloride (NaCl). Target is an SBP >110mmHg.
- **Best**: If there is evidence of bleeding, transfuse whole blood or, if not available, transfuse blood products. Greater emphasis on the use of Low Titer O Whole Blood is the optimal strategy. Target is an SBP >110mmHg.

Hemodynamic Control Notes

- Do not neglect scalp bleeding. This can become a significant source of blood loss. Scalp lacerations should be sutured or stapled as soon as possible.
- Take caution if an underlying skull fracture is present or if there is obvious penetrating trauma. DO NOT tightly pack or irrigate an open head wound. Suture or staple the skin closed, if bleeding. A pressure dressing may be placed if needed to control bleeding.
- Hypotension is usually not caused by TBI except as a late finding due to herniation.[12] Always look for other causes of hypotension, such as ongoing bleeding or tension pneumothorax.
- Urine output (UOP) provides an important assessment of blood supply to the organs. Monitoring continuously by a Foley catheter is ideal. If a Foley catheter is not available, monitor by a graduated cylinder. Goal UOP in a polytrauma patient is 30–50mL/h.[13]
- The role of TXA in TBI patients is currently under investigation in the CRASH-3 trial. Limited data suggest TXA limits ICH expansion and may improve outcomes in TBI patients.[14] Until more definitive data are available, TXA can be used in TBI patients.
- Colloids (e.g., albumin) have demonstrated a trend toward worsening outcomes in brain-injured patients.[15] Hetastarches are associated with coagulopathy and increased risk of kidney injury in trauma patients.
- Avoid colloids and hetastarches in TBI patients; however, they can be used if no alternative is available.

- Avoid hypotonic fluids (including lactated Ringer's) whenever possible; they can make brain swelling worse.

Most trauma patients with moderate or severe TBI will have other traumatic injuries. A careful search for bleeding should be performed in any hypotensive trauma patient.

Brain injury with associated hemorrhagic shock is a complicated scenario with a high risk of death. Balancing hemorrhage control (which is easier with lower blood pressure) with maintaining cerebral perfusion pressure (which requires higher blood pressure) should be guided with expert teleconsultation (i.e. critical care, neurocritical care, neurosurgical) whenever possible.

AIRWAY, OXYGENATION/VENTILATION MANAGEMENT

Goal: Manually maintain or secure the patient's airway and avoid hypoxia, hypocapnia, or hypercapnia to reduce the risk of secondary brain injury. If GCS score is ≤8 or there is facial trauma with compromised airway, a definitive airway is most likely needed. The provider should place the type of airway (i.e. cricothyroidotomy or endotracheal tube [ETT]) that they have the most confidence in placing, based on their training and practice.

- **Minimum**: Nasopharyngeal airway and bag-valve-mask with PEEP valve as needed. Use supplemental oxygen, if available. Maintain SpO_2 >90%.
- **Better**: Perform a cricothyroidotomy/ETT placement or place a supraglottic airway (e.g., laryngeal mask airway [LMA], King laryngeal tube [LT]) followed by continuous sedation and airway maintenance, supplemental oxygen via oxygen concentrator, and portable ventilator to maintain an SpO_2 >95% and $EtCO_2$ of 35–40mmHg.
- **Best**: Cricothyroidotomy or ETT followed by continuous sedation and airway maintenance, supplemental oxygen, portable ventilator. Targets: SpO_2 >95% and $EtCO_2$ 35–40mmHg. Check arterial blood gas results and correlate with $EtCO_2$ within 30 minutes of intubation if laboratory capability is available. A positive end-expiratory pressure (PEEP) of 5cmH_2O should be used routinely. PEEP can be safely increased up to 15cmH_2O if needed to improve SpO_2, but be alert for problems caused by increased intrathoracic pressure (e.g., lower blood pressure or increased ICP).[16]

Airway Management Notes

- Patients with a GCS score ≤8 should undergo placement of an advanced airway (i.e. cricothyroidotomy or ETT) unless arrival to a higher level of care will occur in a timely manner or the airway can be manually maintained. The risk versus benefit of advanced airway placement should be carefully considered and discussed by telemedicine consultation whenever possible.
- Airway interventions may cause transient hypoxia during the procedure. Every effort should be made to optimize airway placement on the first attempt by preoxygenating with supplemental O_2, selecting the most experienced provider available, and using the technique most familiar to the provider.
- Patients typically require less sedation after cricothyroidotomy than after ETT placement. This may help conserve resources if medications are limited.
- Monitor $EtCO_2$ and adjust ventilations to achieve the target range. Avoid hyperventilation ($EtCO_2$ <35mmHg) except in extreme cases where imminent herniation is suspected, because hyperventilation worsens cerebral ischemia. Also avoid hypoventilation ($EtCO_2$ >45mmHg) that will increase ICP.

- Gastric decompression with a nasogastric tube (NGT) or oral gastric tube (OGT) will decrease the risk of aspiration in unconscious patients. If patients required bag-masking, they may have a distended stomach, which, in some patients, contributes to bradycardia. NGT and OGT cannot be placed with a supraglottic airway.

ICP MANAGEMENT

Goal: Suspect high ICP in any head injury patient with GCS score ≤8 OR declining findings on neurologic examination (unless explained by sedation, hypotension, hypoxia, hypercarbia, high fever). Minimize factors that contribute to elevated ICP, such as pain, anxiety, and fever. Rapidly recognize and manage elevated ICP, and maintain an adequate cerebral perfusion pressure.

- **Minimum**: Use general measures to reduce ICP.
  - Elevate head of bed (HOB) 30°–60°.
  - Maintain neck in midline position.
  - Maintain arterial blood oxygen saturation (SpO_2) >90% (or >95% if receiving ventilatory support).
  - Maintain $EtCO_2$ between 35mmHg and 40mm Hg.
  - Maintain core temperature between 96°F and 99.5°F.
  - Maintain SBP >100mmHg, ideally at >110mmHg.
  - Prevent or rapidly manage seizure activity.
  - If concerned for impending herniation (e.g., unresponsive patient with unilateral dilated pupil, presence of Cushing's triad), hyperventilate the patient for no more than 20 minutes to an $EtCO_2$ target of 30mmHg.[17] Seek expert consultation immediately.

The optimum duration of hyperventilation and frequency that can be repeated are not known. If performed, assess response (i.e. pupils, GCS score, and so forth). If patient responds, consider performing again if needed, guided by expert teleconsultation, if possible

- **Better**: Even unconscious patients may experience pain and anxiety, manifested by hypertension (i.e., SBP >160mmHg) and/or agitation. Anxiety and agitation can increase ICP. In addition to all minimum measures, ensure adequate sedation and analgesia by targeting a Richmond Agitation and Sedation Score of −1 to −2. Refer to Joint Trauma System CPG on PFC Analgesia and Sedation.[18]
  - Ketamine 20mg IV/IO
  - Hydromorphone 0.5–2mg IV/IO
  - Fentanyl 25–50µg IV/IO

  In addition to analgesics, consider administration of a rapid-onset, short-duration anxiolytic. Midazolam 1–2mg IV/IO as needed for agitation or anxiety.

- **Best**: In addition to all minimum and better measures, administer osmotic therapy via peripheral intravenous (IV) or intraosseous (IO) access:
  - Hypertonic saline (HTS): 3% NaCl 250mL bolus over 20 minutes; repeat every 3 hours as needed when concerned for elevated ICP.

- Mannitol can be used if there is no sign of bleeding and the SBP is >110mmHg. Mannitol 1g/kg IV/IO over 20 minutes. Repeat at 0.5g/kg IV/IO every 3 hours as needed when concerned for elevated ICP.

Seek additional medical direction as soon as possible and evacuate to neurosurgical care at the earliest opportunity.

ICP Management Notes

- ICP cannot be directly measured without advanced intracranial monitoring devices. Therefore, vigilant clinical observation and the use of noninvasive ICP assessment modalities are critical to monitoring TBI patients until neurosurgical placement of neuromonitoring devices can occur.
- HTS bolus lowers ICP and has a duration of action of approximately 3 hours.[19,20]
- Mannitol, although effective, has several potentially adverse complications. It is a diuretic and might lower the blood pressure. Also, after repeated use, it can cross a damaged blood–brain barrier and potentially worsen ICP.[20] For these reasons, HTS is preferred to mannitol in TBI and polytrauma patients.
- Some institutions have reported ICP-lowering benefits from vertical positioning of patients, particularly when high intraabdominal or intrathoracic pressure is suspected. Lower intraabdominal and intrathoracic pressures may facilitate venous drainage from the intracranial compartment. If safe to do so, this can be attempted when other measures have failed.[21]

Always treat hypotension before treating elevated ICP. Cerebral blood flow is more affected by a decrease in blood pressure than an increase in ICP.

Cerebral perfusion pressure (CPP) = mean arterial pressure (MAP; mmHg) − ICP (mmHg)

Hyperventilation reduces CO_2 and rapidly lowers ICP by causing cerebral vasoconstriction and decreasing the overall cerebral blood volume. However, hyperventilation also damages the brain by causing ischemia and should only be performed for brief periods. Avoid hyperventilation unless all other interventions have been ineffective.[22]

Although there are invasive interventions to help assess and treat elevated ICP, evacuate hematomas, and so forth, such as decompressive craniectomy, extraventricular drains, intracranial bolt monitors, and burr holes, such procedures are not recommended unless the PFC provider has training and experience in performing these procedures and is directed by expert teleconsultation.

INFECTION CONTROL

Goal: Dress all wounds to prevent further exposure to environmental pathogens and administer antibiotic prophylaxis to all patients with penetrating TBI.

- **Minimum**: Dress all wounds to prevent further introduction of infectious materials. Optimize wound and patient hygiene to the extent possible given the environmental and situational conditions.
  - For penetrating head wounds, apply superficial dressings and seal the dressing to the extent possible.

- Bleeding head injuries must be sutured or stapled to control bleeding.
- DO NOT introduce any material into the wound cavity.
- DO NOT attempt to flush the wound.
- Antibiotics are not necessary in TBI without open or penetrating trauma.

- **Better**: Antibiotics should be used for open or penetrating TBI.
  - Ertapenem 1g IV/IO every 24 hours and moxifloxacin 400mg PO every 24 hours for 5 days.

Ertapenam and moxifloxacin may increase the risk of seizure and ertapenam may not penetrate an intact blood-brain barrier. This combination, while commonly available, should only be used in TBI patients when the antibiotics with proven CNS penetration are not available.

- **Best**: Administer CNS-penetrating antibiotics for open or penetrating TBI.
  - Ceftriaxone 2 gm IV/IO every 24 hours or cefazolin 2g IV/IO every 8 hours for 5 days. .
  - Add metronidazole 500mg IV/IO every 8 hours for 5 days for wounds that are grossly contaminated with organic debris (e.g., dirt, debris, clothing).[17]

- **Infection Control Notes**
  - Moxifloxacin may be replaced with levofloxacin 750 mg PO daily to provide better coverage of bacteria found in wet terrain/ jungle environment.
  - If recommended antibiotics are not available or significant drug allergies are present, obtain teleconsultation to discuss alternative medications. Additional detailed recommendations may found in Forgione et al.[23]

SEIZURE PROPHYLAXIS AND MANAGEMENT

Goal: Rapidly identify and manage seizure activity in TBI patients.

- **Minimum**: For witnessed convulsive seizure activity, place the patient on his/her side and clear the area of any potentially harmful objects. Suction the mouth if possible, but DO NOT attempt to place anything inside a seizing patient's mouth. Treat any witnessed or suspected seizures with a rapid-acting benzodiazepine.
  - Midazolam 5mg IV/IO/IM every 5 minutes until seizure stops.
  - An alternate benzodiazepine can be used if available (diazepam 5mg IV every 5 minutes until seizure stops; lorazepam 4mg IV every 5 minutes until seizure stops).

- **Best**: For witnessed or suspected seizures, administer a rapidly acting benzodiazepine (midazolam 5mg IV/IO/intramuscularly [IM]) plus a maintenance antiepilepsy drug. Broad-spectrum IV agents such as levetiracetam (Keppra; UCB Pharma, http://www.ucb.com/) are preferred.
  - Maintenance antiepilepsy-drug dosing: Levetiracetam: 2000mg IV/IO loading dose over 15 minutes followed by maintenance dosing of 500mg IV/IO every 12 hours.
  - Alternate maintenance antiepilepsy drugs:

- Phenytoin (loading dose: 1.5g IV over 1 hour, then 100mg PO/IV/IO every 8 hours)
- Phenobarbital (loading dose: 1.5g IV/IO over 1 hour, then 100mg PO/IV/IO daily). Be ready to support ventilation if phenobarbital is used.

Seizure Notes

- Not all seizures are easy to see. At times, the findings may be obvious with generalized convulsions, or they may be subtle (e.g., persistent twitching of facial muscles, fingers).
- Risk factors for seizures after TBI include: GCS score <10, skull fractures, penetrating injuries, prolonged length of coma (>24 hours).[24]
- Non-convulsive seizures (NCSs) should be considered in any TBI patient with a GCS score ≤8 and who does not improve with appropriate resuscitation and/or ICP management. NCSs may persist after convulsive seizures are stopped and may be associated with higher morbidity and mortality.[25] The most common signs of patients with NCS are coma, delirium, agitation, aphasia (impairment of language affecting production and/or comprehension of speech, reading, and/or writing) and/or "blank staring."
- Prompt initiation of seizure prophylaxis reduces early seizures after TBI.[26] In PFC settings, where possible, an anti-epilepsy drug should be used early after injury to help prevent seizure.
- Midazolam has a high rate of seizure control and works rapidly to terminate seizure activity.[27] Midazolam is preferred because it is a short-acting medication (elimination time: 2–4 hours) and will allow for more regular and comprehensive neurologic examinations. It can be given IM in patients who do not yet have IV/IO access.
- If not already placed, strong consideration should be given to placing an advanced airway (cricothyroidotomy or ETT) in any TBI patient who experiences seizures (place airway after seizures are controlled).

FEVER CONTROL

Goal: Maintain core temperature between 96°F and 99.5°F. Treat fever aggressively in TBI patients with a combination of medication, cold fluid boluses, and surface cooling techniques.

- **Minimum**: Ensure patient has been removed from heat or sun. Remove clothes to allow evaporative cooling, Use surface-cooling measures (e.g., evaporative heat loss by misting and fan cooling) to reduce core body temperature.
- **Better**: Apply cold packs to axillary regions, posterior cervical region, and the groin.
- **Best**: Acetaminophen 650mg every 4 hours orally (PO) or rectally as needed for rectal temperatures >99.5°F. Additionally, cold saline IV fluid bolus can be used for refractory fever, if available.

Fever Notes

- Fever will increase cerebral metabolism and may increase ICP.
- Although targeted temperature management (previously referred to as therapeutic hypothermia) is used to reduce ICP in a critical care setting, hypothermia is part of the "lethal triad" in trauma patients, along with coagulopathy and acidosis. Targeted temperature management strategies beyond what is outlined in TCCC should NOT be attempted in the field or Role 1 setting.

- Hypothermia prevention and management kits should continue to be used in all trauma patients. In TBI patients, however, warming measures should be avoided when the core body temperature is above the target range.

Avoid non-steroidal anti-inflammatory drugs (NSAIDs), such as ibuprofen, naproxen, ketorolac. Although these agents can effectively lower temperature, their antiplatelet effect may increase bleeding in TBI if intracranial hemorrhage is present (e.g., epidural hematomas, subdural hematomas).

SODIUM MANAGEMENT

Goal: Avoid hyponatremia, which can worsen brain swelling. The target serum sodium level in patients with severe TBI is slightly above normal, between 145mmol/L and 160mmol/L.

- **Minimum**: Avoid the administration of any free water or hypotonic fluids that will lower serum sodium levels.
- **Best**: Monitor serum sodium level via blood sampling. In a stable patient, check sodium level every 6 hours. In an unstable patient, or in a patient receiving HTS, check sodium level every 3 hours. Adjust fluids as needed to meet the sodium goals.

Sodium Management Notes

- Several conditions can develop rapidly in brain-injured patients that can lower serum sodium levels (e.g., cerebral salt wasting, syndrome of inappropriate antidiuretic hormone secretion) or raise serum sodium levels (e.g., diabetes insipidus). Sodium levels, fluid intake, and urine output should be monitored closely.
- If laboratory testing for serum sodium level is not available, then, as a reference, 250mL of 3% saline can be expected to raise the serum sodium level of an 80kg patient approximately 2–3mmol/L. Assuming a normal serum level of 140mmol/L before starting HTS therapy, it would take six 250mL bags of 3% HTS to raise the serum sodium to concerning levels (i.e. >160mmol/L). This is without factoring in the regulation of serum sodium by the kidneys. If patient is urinating, it will be difficult to raise serum sodium above 160mmol/L with 3% HTS. If patient is not urinating, more caution should be used because sodium levels can build up more quickly.

Obtain telemedicine consultation, preferably from a critical care or neurocritical care expert, before giving more than two 250mL boluses of 3% NaCl HTS.

BLOOD GLUCOSE CONTROL

Goal: Avoid both hypolgycemia and hyperglycemia. Target a blood glucose level of 180mg/dL via handheld glucometer.

- **Minimum**: Monitor for clinical signs and symptoms of hypoglycemia (e.g., sweating, confusion, tremor, generalized weakness, generalized lethargy). If patient is hungry and able to safely swallow, allow the patient to eat to avoid hypoglycemia. Avoid the administration of any substances that are excessively high in sugar or carbohydrate content to prevent hyperglycemia.
- **Best**: Check blood glucose level every 6 hours. If glucose level is <100mg/dL, give 20g of oral glucose (5 teaspoons of sugar or 4 teaspoons of honey) PO or by NG tube. Or administer 25g (50mL) dextrose 50% in water (D50) solution IV/IO. Recheck blood glucose in 1 hour, then continue to check every 6 hours.

Blood Glucose Control Notes

- Hypoglycemia is more harmful to the brain than hyperglycemia.
- Hyperglycemia may occur in TBI as an acute stress response or as a result of brain-induced catecholamine release. Early hyperglycemia (i.e., >180mg/dL) has been associated with poor neurologic outcome in severe TBI.[28]
- The treatment of hyperglycemia requires insulin. If the appropriate medications, laboratory capability, and expertise are available, hyperglycemia may be treated; however, the treatment of hyperglycemia is not covered in this CPG.

TRANSPORTATION CONSIDERATIONS

Goal: Safely prepare TBI patients for ground and/or air transportation to higher levels of care.

- **Minimum**: Dose sedative/analgesic medications, osmotic agent, and/or benzodiazepine before any significant ground or air transportation, as resources permit.

  Neuromuscular blocking agents will mask seizures and clinical examination changes; therefore, the risk versus benefit of use during transport must be considered.

- **Best**: Ensure transport assets are aware of the patient's brain injury in advance so appropriate accommodations and/or alterations to the travel plan can be made.
  - Most patients are transported in a supine position. Every effort should be made to transport TBI patients with the HOB elevated to at least 30°.
  - For fixed-wing transport, TBI patients should be loaded with their head toward the front of the aircraft to minimize G-forces transmitted to the brain.
  - Air transport of TBI patients requires additional considerations. For air movements that involve altitudes >8,000 ft, TBI patients are at risk for additional complications that may worsen brain injury, such as hypobaric hypoxia and high-altitude cerebral edema.[29] Preplanning with air assets is highly recommended.
- Recommended Packing List. See Appendix D.
- Management of Traumatic Brain Injury Summary Table. See Appendix E.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All patients with a diagnosis of traumatic brain injury and an initial GCS of 3-8.
2. All patients who receive a cranial procedure (ICP monitor, craniectomy, craniotomy).

INTENT

1. All patients in population of interest avoid hypotension and hypoxia: SBP never < 100 mmHg, MAP never < 60, SaO2 never < 93%.

2. All patients in population of interest have PaCO2 monitored at every role of care.
3. All patients in population of interest have a head CT performed within 4 hours of injury.
4. All patients with a ventriculostomy have hourly documentation of ICP/CPP and ventriculostomy output.
5. Patients in population of interest unable to be monitored clinically (e.g., unable to hold sedation for Q1 hour neuro exam) have an ICP monitor or ventriculostomy placed prior to transport out of theater.

METRICS

1. Number and percentage of patients in the population of interest with lowest SBP<100 within first 3 days after injury.
2. Number and percentage of patients in the population of interest with MAP<60 within first 3 days after injury.
3. Number and percentage of patients in the population of interest with SaO2<93% within first 3 days after injury.
4. Number and percentage of patients in population of interest who have PaCO2 documented at every role of care (POI, POI MEDEVAC, ROLE 2-4, interfacility MEDEVAC).
5. Number and percentage of patients in the population of interest who maintain PaCO2=35-40
6. Number and percentage of patients who had a head CT performed within 4 hours of injury.
7. Number and percentage of patients with a ventriculostomy who had hourly documentation of ICP/CPP and ventriculostomy output.
8. Number and percentage of patients in the population of interest unable to be monitored clinically (eg. unable to hold sedation for Q1 hour neuro exam) who have an ICP monitor or ventriculostomy placed prior to transport out of theater.

DATA SOURCE

- Patient Record and the ASIA or Combat Neuro Exam worksheet
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief and the PI Branch.

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APPENDIX A: NEUROLOGICAL EXAMINATION

I. MENTAL STATUS

Level of Consciousness: Note whether the patient is:

- Alert/responsive
- Not alert but arouses to verbal stimulation
- Not alert but responds to painful stimulation
- Unresponsive

Orientation: Assess the patient's ability to provide:

- Name
- Current location
- Current date
- Current situation (e.g., ask the patient what happened to him/her)

Language: Note the fluency and appropriateness of the patient's response to questions. Note patient's ability to follow commands when assessing other functions (e.g., smiling, grip strength, wiggling toes). Ask the patient to name a simple object (e.g., thumb, glove, watch).

Speech: Observe for evidence of slurred speech.

II. CRANIAL NERVES

All patients:

- Assess the pupillary response to light.
- Assess position of the eyes and note any movements (e.g., midline, gaze deviated left or right, nystagmus, eyes move together versus uncoupled movements).

Noncomatose patient:

- Test sensation to light touch on both sides of the face.
- Ask patient to smile and raise eyebrows, and observe for symmetry.
- Ask the patient to say "Ahhh" and directly observe for symmetric palatal elevation.

Comatose patient:

- Check corneal reflexes; stimulation should trigger eyelid closure.
- Observe for facial grimacing with painful stimuli.
- Note symmetry and strength.
- Directly stimulate the back of the throat and look for a gag, tearing, and/or cough.

III. MOTOR

Tone: Note whether resting tone is increased (i.e. spastic or rigid), normal, or decreased (flaccid).

Strength: Observe for spontaneous movement of extremities and note any asymmetry of movement (i.e. patient moves left side more than right side). Lift arms and legs, and note whether the limbs fall immediately, drift, or can be maintained against gravity. Push and pull against the upper and lower extremities and note any resistance given. Note any differences in resistance provided between the left and right sides.

(NOTE: it is often difficult to perform formal strength testing in TBI patients. Unless the patient is awake and cooperative, reliable strength testing is difficult.)

Involuntary movements: Note any involuntary movements (e.g., twitching, tremor, myoclonus) involving the face, arms, legs, or trunk.

IV. SENSORY

If patient is not responsive to voice, test central pain and peripheral pain.

Central pain: Apply a sternal rub or supraorbital pressure, and note the response (e.g., extensor posturing, flexor posturing, localization).

Peripheral pain: Apply nail bed pressure or take muscle between the fingers, compress, and rotate the wrist (do not pinch the skin). Muscle in the axillary region and inner thigh is recommended. Apply similar stimulus to all four limbs and note the response (e.g., extensor posturing, flexor posturing, withdrawal, localization).

NOTE: In an awake and cooperative patient, testing light touch is recommended. It is unnecessary to apply painful stimuli to an awake and cooperative patient.

V. GAIT

If the patient is able to walk, observe his/her casual gait and note any instability, drift, sway, and so forth.

APPENDIX B: ULTRASONIC ASSESSMENT OF OPTIC NERVE SHEATH DIAMETER

If a patient is unconscious (i.e. does not follow commands or open eyes spontaneously), they may have elevated ICP. There is no reliable test for elevated ICP available outside of a hospital; however, optic nerve sheath diameter (ONSD) measurement is a rapid, safe, and easy-to-perform ultrasonographic assessment that may help identify elevated ICP when more definitive monitoring devices are not available.

- The optic nerve sheath directly communicates with the intracranial subarachnoid space. Increased ICP, therefore, displaces cerebrospinal fluid along this pathway. Normal ONSD is 4.1–5.9mm.[30]
- A 10–5-MHz linear ultrasound probe can be used to obtain ONSDs. ONSD is measured from one side of the optic nerve sheath to the other at a distance of 3mm behind the eye immediately below the sclera.[31]
- In general, ONSDs >5.2mm should raise concern for clinically significant elevations in ICP in unconscious TBI patients.[5,32] The ONSD can vary significantly in normal individuals, so one single measurement may not be helpful; however, repeated measurements that detect gradual increases in ONSD over time may be more useful than a single measurement.
- ONSD changes rapidly when the ICP changes, so it can be measured frequently.[33] If ONSD is used, it is best to check hourly along with the neurologic examination.

TECHNIQUE

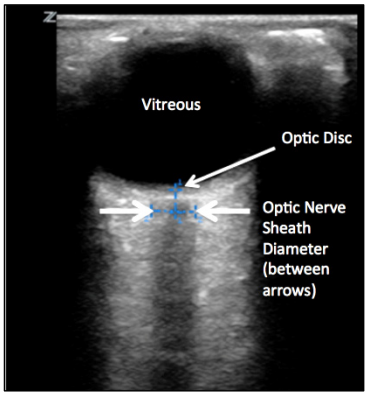
1. Check to make sure there is no eye injury. A penetrating injury to the eyeball is an absolute contraindication to ultrasound because it puts pressure on the eye.
2. Ensure the head and neck are in a midline position. Gentle sedation and/or analgesia may be necessary to obtain accurate measurements.
3. Ensure the eyelids are closed.
4. If available, place a thin, transparent film (e.g., Tegaderm; 3M, http://www.3m.com) over the closed eyelids.
5. Apply a small amount of ultrasound gel to closed eyelid.
6. Place the 10(–5)MHz linear probe over the eyelid. The probe should be applied in a horizontal orientation (Figure 1) with as little pressure as possible applied to the globe.
7. Manipulate the probe until the nerve and nerve sheath are visible at the bottom of screen. An example of a proper ultrasonagraphic image of the optic nerve sheath can be seen in Figure 2.
8. Once the optic nerve sheath is visualized, freeze the image on the screen.
9. Using the device's measuring tool, measure 3mm back from the optic disc and then obtain a second measurement perpendicular to the first. The second measurement should cover the horizontal width of the optic nerve sheath (Figure 2). An abnormal ONSD is shown in Figure 3.
10. Repeat the previous sequence in the opposite eye. Annotate both ONSDs on the PFC Casualty Card.
11. ONSDs should be obtained, when possible, at regular intervals to help assess changes in ICP, particularly when the neurologic examination is poor and/or unreliable (i.e. with sedation). Serial measurements with progressive diameter enlargement and/or asymmetry in ONSDs should be considered indicative of worsening intracranial hypertension.

CAUTION: ONSD measurements are contraindicated in eye injuries. NEVER apply pressure to an injured eye.

Figure 1. *Appropriate placement of the linear probe.*

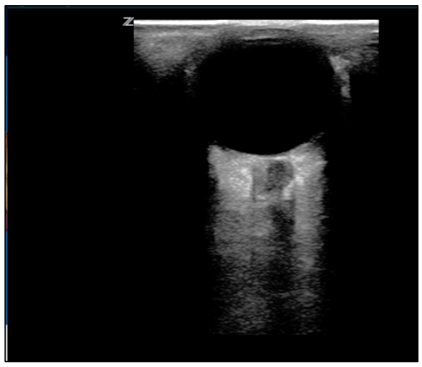
Ultrasound gel is placed over a closed eyelid and the probe placed horizontally over the eyelid, applying as little pressure to the globe as possible. If available, Tegaderm or other thin covering (e.g., Latex glove) should be placed over a closed eyelid for further protection.

Figure 2 *An ultrasonographic view of a normal eye and optic nerve sheath.*



To measure ONSD, apply the ultrasound measuring device to the optic disc and measure back 3mm along the length of the optic nerve. A second, perpendicular measurement is obtained at the previously measured point that spans the horizontal width of the optic nerve sheath. In this image, ONSD was determined to be 5.1mm, a normal value.

Figure 3*. Ultrasound image of the right optic nerve sheath of a 61-year-old man with a traumatic subdural hematoma.*



The optic nerve sheath measured 6.8mm in diameter. Elevated ICP was subsequently confirmed (26mmHg) after the placement of an ICP bolt monitor.

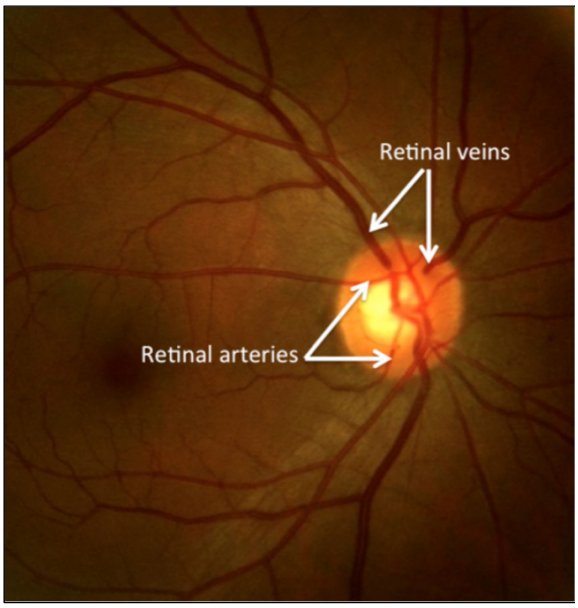
APPENDIX C: SPONTANEOUS VENOUS PULSATIONS

- Spontaneous venous pulsations (SVPs) are subtle, rhythmic variations in retinal vein caliber on the optic disc and have an association with ICP.
- It is difficult to see SVPs without advanced equipment; however, if a handheld ophthalmoscope is available, it is worth an attempt to visualize the retinal veins.
- Don't worry if you cannot see SVPs; this may actually be normal. However, if you do see them, it is very reassuring that ICP is normal.[10]
- If SVPs are initially present and can no longer be seen on subsequent examinations, the provider should be concerned for increasing ICP.

TECHNIQUE

1. Gently lift the eyelid until the pupil is in view.
2. Using a handheld ophthalmoscope, the provider should maneuver himself or herself to a position where the optic disc can be visualized.
3. Identify the retinal veins as they emerge from the optic disc. Retinal veins are typically slightly larger and darker than retinal arteries. Figure 1 demonstrates the typical appearance of the retina.
4. Observe the retinal veins for pulsations. Note the presence or absence of spontaneous venous pulsations
5. Repeat the step 1–4 sequence in the contralateral eye.

Figure 1. *Typical appearance of a healthy retina.*



The retinal vessels can be seen emerging from the optic disc. Retinal veins can be identified by their slightly larger, thicker size and darker color. Retinal arteries are small, thin, and lighter in color than retinal veins.

APPENDIX D: RECOMMENDED PACKING LIST

Assumptions: One patient with a moderate to severe traumatic brain injury. To calculate the amount of fluid or medication you would need for a single TBI patient, use your worst case, longest possible evacuation extrapolated from your mission planning. For example, if you think you might have a 36-hour evacuation, you might need 3,500mg levetiracetam (a 2,000mg loading dose and 500mg every 12 hours)

MINIMUM

- **Equipment**: vital-sign trending chart, BP cuff, stethoscope, wrist watch, pulse oximeter, capnometer, cricothyroidotomy kit, bag-valve-mask with PEEP valve, nasopharyngeal airway, disposable thermometer, Nalgene bottle to measure urine
- Medications/Fluids: ketamine, midazolam, lorazepam, acetaminophen, ceftriaxone, 3% hypertonic saline

BETTER

- **Equipment**: portable vital sign monitor, capnometer, cricothyroidotomy kit and/or ETT plus laryngoscope/glidescope and/or laryngeal mask airway, cold/ice packs, graduated cylinder to measure urine, oxygen concentrator
- Medications/Fluids: ketamine, IV hydromorphone, IV fentanyl, midazolam

BEST

- **Equipment**: portable monitor providing continuous vital-signs display with capnography, cricothyroidotomy kit, and/or ETT plus laryngoscope/glidescope, portable point-of care-testing device such as an iStat (Abbott Point of Care; https://www.pointofcare.abbott) or Epoch (Alere, http://www.alere.com) for arterial blood gas samples, and electrolyte monitoring, blood glucose monitor, Foley catheter kit, and supplemental oxygen or oxygen concentrator
- Medications/Fluids: Fresh whole blood drawing supplies or stored blood products, 3% hypertonic saline, mannitol, ceftriaxone, metronidazole, levetiracetam or phenytoin, acetaminophen, dextrose 50% in water

OTHER PACKING LIST CONSIDERATIONS

- **Equipment**: Portable ultrasound, nasogastric tube, red- (or red/yellow-speckled) top test tubes to test for electrolytes if a host-nation laboratory is available
- Medications/Fluids: TXA

APPENDIX E: MANAGEMENT OF TRAUMATIC BRAIN INJURY SUMMARY TABLE

Management of Traumatic Brain Injury Summary			
GOAL	**MINIMUM**	**BETTER**	**BEST**
Neurological Assessment			
Goal: Rapidly identify TBI and associated injuries; assess TBI severity.	Consider: If patient is unconscious, measure a baseline optic nerve sheath diameter with ultrasound using a 10(–5)MHz linear probe.	Secondary survey: Evaluate for TBI red flags. Perform detailed neurologic examination.	Primary survey: Perform rapid trauma survey to assess all injuries. Determine and record Glasgow Coma Score. Assess pupils and motor function in all four extremities. Recognize Cushing's triad.
ONSD should not be attempted on any patient with an open globe injury to the eye. Cushing's triad: increased SBP/widened pulse pressure, bradycardia, irregular breathing (typically rapid/shallow)			
Monitoring			
Prevent secondary brain injury, maintain adequate oxygenation and ventilation, avoid hypotension, detect elevated ICP.	Blood pressure cuff, stethoscope, pulse oximeter, method to monitor urine output. If advanced airway is in place, monitor $EtCO_2$ with capnometer. Check pupils and GCS hourly or as often as possible.		Portable monitor with continuous vital-signs display, Foley catheter to monitor urine output. If advanced airway in place, monitor end-tidal CO_2 ($EtCO_2$) with capnography. Check pupils and GCS hourly.
Neurologic examination and vital-sign trends are essential to identifying a deteriorating patient with TBI. Monitoring $EtCO_2$ is critical for severe TBI patients. Bring the correct equipment whenever possible.			
Management Hemodynamic Control			
Maintain systolic pressure >110mmHg	Stop all external bleeding. Manage internal bleeding to the extent possible with available resources. Administer TXA per TCCC guidelines. Avoid medications that may lower the blood pressure.	If there is evidence of bleeding and no blood products are available, 0.9% sodium chloride 1L. Target SBP: >110mmHg	If evidence of bleeding, transfuse whole blood or, if not available, transfuse blood products per TCCC guidelines. Target SBP: >110mmHg
Brain injury in the presence of hemorrhagic shock requires balancing hemorrhage control with cerebral perfusion. Telemedicine consultation is strongly encouraged. Do not neglect scalp bleeding. Take care to inspect for skull fractures. DO NOT tightly pack an open head wound. Hypotonic fluids (to include lactated Ringer's) should be avoided whenever possible because they can worsen cerebral edema.			
Management: Airway, Oxygenation/Ventilation			
Maintain or secure airway. If GCS score ≤8 or there is facial trauma or other airway compromise, consider definitive airway placement.	Nasopharyngeal airway and bag-valve-mask with PEEP. Supplemental oxygen, if available. Maintain SpO_2 >90%.	Perform cricothyroidotomy/ETT or place supraglottic airway followed by continuous sedation, supplemental O_2, portable ventilator. Target SpO_2: >95%, $EtCO_2$: 35–40mmHg.	Perform cricothyroidotomy/ETT followed by continuous sedation, supplemental O_2, portable ventilator. Target SpO_2 >95%, $EtCO_2$ 35–40. Check arterial blood gas values. PEEP: 5cmH_2O (increase up to 15cmH_2O if needed).
Avoid hyperventilation except in extreme cases where imminent cerebral herniation is suspected.			
Management ICP			
Suspect high ICP in any head injury patient with GCS score ≤8 or declining findings on neurologic examination. Minimize factors that could contribute to elevated ICP, such as pain, anxiety, and fever.	• Elevate HOB 30–45° • Neck midline, loosen collar • SBP >110mmHg (or at least > 100mmHg) • SpO_2 >90% or 95% on ventilator • $EtCO_2$ 35–40mmHg • Core temp 96–99.5°F • Prevent/treat seizure • Last choice if sign of herniation: hyperventilate to $EtCO_2$ 30mmHg × 20 minutes.	In addition to minimum steps, ensure adequate sedation and analgesia. If SBP >160mmHg or agitated: • Ketamine 20mg IV/IO • Hydromorphone 0.5–2mg IV/IO • Fentanyl 25–50µg IV/IO • Midazolam 1–2mg IV/IO	In addition to minimum and better steps, give osmotic therapy IV/IO: • HTS 3% 250mL over 20 minutes. Repeat every 3 hours if needed. • Mannitol (If no bleeding and SBP >110mmHg) 1g/kg IV/IO over 20 minutes, repeat 0.5g/kg every 3 hours, if needed.
Telemedicine consultation early and often in the patient with elevated ICP.			
Management: Infection Control			
Dress all wounds and administer antibiotic prophylaxis for penetrating brain injuries and open wounds.	Dress all wounds to prevent further introduction of infection. Optimize wound care and patient hygiene to extent possible.	Ertapenem 1g IV/IO every 24 hours and moxifloxacin 400mg PO every 24 hours for 5 days.	Use an antibiotic with strong CNS penetration. • Ceftriaxone 2 gm IV/IO every 24 hours or cefazolin 2g IV/IO every 8 hours for 5 days • Add metronidazole 500mg IV/IO every 8 hours if wounds contaminated with organic debris.
Moxifloxacin may be replaced with levofloxacin 750 mg PO daily to provide better coverage of bacteria found in wet terrain/ jungle environment. Ertapenam and moxifloxacin may increase the risk of seizure and ertapenam may not penetrate an intact blood-brain barrier. If recommended antibiotics are not available or significant drug allergies are present, obtain teleconsultation to discuss alternative medications.			

Management of Traumatic Brain Injury Summary			
GOAL	**MINIMUM**	**BETTER**	**BEST**
Management: Seizures			
Rapidly identify and manage seizures.	For a witnessed or suspected seizure, ensure safety and airway is clear. Treat with rapid-acting benzodiazepine: · Midazolam 5mg IV/IO/IM every 5 minutes until seizure stops		Levetiracetam 2,000mg IV/IO loading dose over 15 minutes + 500mg every 12 hours. Alternate therapy: · Phenytoin 1.5g IV/IO load + 100mg IV/IO every 8 hours · Phenobarbital 1.5g IV/IO load + 100mg IV/IO daily.
Consider nonconvulsive seizures in any TBI patient with GCS score ≤8 who is not improving with appropriate treatments. If not already placed, consider a definitive airway in any patient who experiences seizure. Perform after seizures are controlled.			
Management: Fever Control			
Maintain core temperature between 96°F and 99.5°F. Treat fever aggressively.	Remove patient from heat or sun. Remove clothing. Use surface cooling measures with misting and fan cooling	Apply cold packs to axillary, posterior cervical, and groin regions.	Acetaminophen 650mg every 4 hours PO or rectally for rectal temperature >99.5°F. Cold saline IV bolus if available.
Avoid NSAIDs, such as ibuprofen, naproxen, and ketorolac, because these agents may increase intracranial hemorrhage, if present.			
Management: Sodium Control			
Avoid hyponatremia. Mild hypernatremia optimal. Target sodium level: 145–160mmol/L.	Avoid administration of free water or hypotonic fluids.		Monitor serum sodium via laboratory blood samples. If patient is stable, check levels every 6 hours. In an unstable patient or one receiving HTS, check sodium level every 3 hours and adjust fluids as needed.
Numerous conditions can rapidly affect sodium levels in TBI patients. Monitor sodium and urine output whenever possible.			
Management: Blood Glucose Control			
Avoid both hypo- and hyperglycemia. Target blood glucose 100–180mg/dL.	Monitor for signs and symptoms of hypoglycemia. Allow patient to eat as long as they are able.		Check blood glucose every 6 hours with handheld glucometer. If <100mg/dL, give 25g (50mL) dextrose 50% (D50) IV/IO or 5tsp sugar/4tsp honey PO/NG.
Transportation			
TBI patients for ground and/or air transport to higher levels of care.	Dose sedative/analgesic medications, osmotic therapies, and/or benzodiazepines before any significant ground or air transport if possible.		Provide a detailed brief to the transport assets specifically highlighting any neurologic deficits and treatments and/or accommodations required during transport.
Neuromuscular blockers should only be used when the benefit outweighs the risks. Most patients should be transported in the supine position with the HOB elevated at least 30°. **For fixed-wing aircrafts: load patient with head to the front of the aircraft to minimize G-forces transmitted to the brain. **For altitudes >8000 ft, TBI patients are at risk of hypobaric hypoxia and high-altitude cerebral edema (HACE), which can worsen brain injuries.			

APPENDIX F: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Unexploded Ordnance (UXO) Management (CPG ID: 41)

This CPG provides details on the procedures to safely remove unexploded ordnance from combat patients, both loose and impaled, to minimize the risks to providers and the medical treatment facility while ensuring the best outcome for the patient.

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INTRODUCTION

The purpose of this Clinical Practice Guide (CPG) is to provide details on the procedures to safely remove Unexploded Ordnance (UXO) from combat patients, both loose and impaled, to minimize the risks to providers and the Medical Treatment Facility (MTF) while ensuring the best outcome for the patient. Military ordnance, to include bullets, grenades, flares, and explosive ordnance, retained by a patient can be a risk to all individuals and equipment along the continuum of care. This is especially true from the point of injury to the first treatment facility. Ordnance can be categorized in many ways. For the purposes of patient care, it can be considered "loose," referring to items on the patient's gear or stored in their pockets, or "impaled" when it penetrates into the body.[1] While loose ordnance is fairly common among military patients and easy to address, embedded ordnance is rare and significantly increases the risk for the treatment team. Thirty-six reported cases of impaled ordnance from WWII through the Somalia conflict were discussed in a 1999 review article published in Military Medicine.[2] While cases have occurred in other non-US combat zones, this is held as the best-documented report of impaled ordnance. Of these cases, four were moribund upon arrival to advanced care and died while the other 32 survived their initial surgery. Of note, none of the 36 impaled UXO devices detonated or injured those caring for their patients. Four cases in Afghanistan and two in Iraq since 2005, with another US case reported from Pakistan in 2012, indicate that the risk of similar events is still present.[3] Prior planning, establishment of an standard operating procedure and realistic training are the best ways to prepare for managing these soldiers and avoid "on the fly" decision-making. However, if a patient arrives early on in the establishment of a MTF, expeditious and flexible management by medical leaders faced with the prospect of surgically removing UXO will have the greatest impact on patient and treating team survival. A discussion of steps to avoid accidental discharge of the ordnance and steps to mitigate risks to providers and the surgical facility follows. These protective principles may also be applied to the management of ordinance (e.g., suicide vest) found on non-military patients treated at medical facilities.

ORDINANCE TRIGGERING MECHANISMS

Fundamental to this discussion is a basic understanding of triggering mechanisms for those ordnance types most likely to become impaled in the body. These include mortars, Rocket Propelled Grenades (RPG) and 40 mm projectiles (rifle-launched grenades). A basic, unclassified understanding on how triggering and arming of the explosive round occurs will ensure the surgeon and surgical team avoid causing the ordnance to explode.

Previous reports of UXO reveal that the impaled round was some sort of propelled explosive device. These rounds basically consist of a propulsion system, a trigger mechanism, and a main explosive charge.

It should be assumed that a malfunction occurred causing the ordnance not to explode on impact into the patient. One should always assume that an inadvertent bypass of the safety mechanism or a malfunction could cause the ordnance to explode. All retained ordnance should therefore be considered "armed" or activated to a degree that final triggering of the fuse would cause the ordnance to explode. Fusing and triggering mechanisms vary by the type and variety of ordnance and may even vary within the same type of ordnance depending on where the ordnance was manufactured.

The trigger is generally located at the tip of the main explosive charge. This trigger activates a firing mechanism that impacts onto a percussion cap that activates a detonator. The detonator explodes, thereby igniting the primary explosive charge.

There are a variety of arming mechanisms for explosive ordnance. Typically, a mortar or rifle grenades (e.g., 40mm, M203) becomes armed and capable of exploding based on the number of rotations or spins completed after leaving the launching tube. Upon impact, a nail-like device located in the cone or nose of the device is

pushed down into a fissile explosive that detonates the actual explosive charge. Pressure on the nose of the mortar may also trigger the device to explode.

Piezoelectric crystals are also utilized as another arming mechanism. This is most commonly employed in an RPG. The rocket consists of a propulsion device and stabilizing fins for flight. The trigger utilizes a piezoelectric crystal at the tip of the projectile that generates an electric charge upon direct impact with the target. This charge ignites the detonator that explodes the primary charge. This crystal may also be activated upon exposure to light, electricity, or thermal energy. Therefore, the explosive device may be triggered by reorienting the patient, shining direct sunlight on the crystal, or providing a direct electric current to the device such as contact with an electro cautery device.

ROUTINE INITIAL MEASURES

All patients, regardless of whether they are friendly or enemy, require an initial inspection in order to find and remove all weapons and ammunition prior to entry into a transport vehicle or treatment facility. Screening of their bags and the litter is also essential to ensure that no "loose" ordnance or ammunition is brought into an area where they could be accidentally armed and detonated. Items should be given to the soldier's unit representatives or the area Explosive Ordnance Disposal (EOD) team or placed in a safe location (e.g., UXO pit) if these are not available. If "impaled" ordnance is identified during the initial inspection or triage, all non-essential individuals should go to a safe location and the higher command should be notified. In addition, it should be stated that a patient may have "impaled" ordnance that is not recognized until after initial Tactical Combat Casualty Care has been provided, ground or air transportation has been completed, or even during surgery. Therefore, individuals must always be prepared to execute the appropriate measures at any time during the continuum of patient care. Refer to Table 1 in Appendix A for more guidance.

TRANSPORT OF PATIENTS WITH SUSPECTED/CONFIRMED UXO

Casualties with suspected or confirmed "impaled" UXO should only be moved or evacuated if absolutely necessary. Whenever possible, surgical or diagnostic capabilities should be moved to the casualty's location in order to decrease the chance of vibration or travel over rough terrain resulting in UXO detonation. If movement is required, the patient should be extracted and positioned in the same position they were found as repositioning the patient may cause the ordnance to shift and trigger a charge. If the patient requires rotary wing transportation while the ordnance remains in place, it is essential to properly ground the patient to the helicopter to avoid static electricity causing the ordnance to trigger and explode. The aircrew must be consulted to ensure proper grounding of the patient to the aircraft.

COMMAND DECISION PRIORITIES AT COMPOUND WITH TREATMENT FACILITY

Safe removal of UXO requires significant coordination with local security, the base command element, and EOD personnel. Specific duties include:

BASE SECURITY AND COMMAND TEAM

The area where the patient is located should be secured or cordoned off. The time to identify this area is during the initial establishment of a treatment facility, long before a potential patient may arrive in need of care. Non-treating personnel should remain in protected location at a safe distance beyond the blast radius of the ordnance. All non-essential personnel, including medical providers, should move to that stand off point. The local commander should be informed that a patient with UXO is under medical care at the MTF or is due to arrive if prior notification is given.

EXPLOSIVE ORDNANCE DISPOSAL TEAM

It is imperative that EOD staff participate in mass casualty exercises involving UXO scenarios in order to develop robust procedures and guidelines. Furthermore, EOD can advise and assist in construction of a UXO barricade where the UXO can be removed and a second secured area to place the UXO once it has been removed following surgery. This is best done after the primary MTF has been established. The EOD unit contact information should be clearly posted in the surgical facilities administrative area and the phone number validated periodically. The EOD technician or other subject matter expert must provide input on the type of ordnance present, whether the explosive portion is still present, and the likelihood of detonation. All of this information must be factored into a risk benefit analysis. As the common impaled ordnance types have a number of variants, the EOD specialist can provide advice on specific concerns to prevent arming and detonating the device. In some instances, EOD technicians have assisted in removal of the ordnance during surgery.

PATIENT TRIAGE

During patient triage, the triaging officer must always inspect soldiers for loose UXO and impaled UXO. This must occur at all levels of care within the evacuation chain. If possible, the initial triage of the patients once at an MTF should be done outside the main treatment facility. Ideally, this is done nearby, but at a safe standoff distance. To assist with this, standard metal detector wands can be used with little risk of causing loose or impaled UXO to arm or detonate. During mass casualty situations, a patient with an impaled UXO could potentially endanger the staff, other patients, ground and rotary transport vehicles and drivers, and the main MTF. If there is a low probability of survival, they must be triaged to a delayed or expectant category, particularly when there are multiple casualties requiring surgical care. Comfort care, when appropriate, can be provided with the patient moved to a safe distance from the fixed or tented surgical facility.

ANCILLARY SURGICAL SITE

Safe removal of the UXO should be accomplished in an ancillary surgical site when time and casualty flow permit. This is done to avoid bringing the ordnance into the main Operating Rooms (ORs). This ancillary site should be established outside the main surgical facility where the removal of the ordnance can be expeditiously and safely performed. This site should also be well lit and have all the necessary anesthetic and surgical equipment readily available. The floor should be level and large enough to place a field operating table, a litter stand, or a litter on a wheeled litter system since it can be moved with minimal amount of personnel and can immediately be converted to a stable platform for performing surgery. Ensure that the set-up can accommodate the use of portable X-ray since it may be required to help identify the ordnance. Ideally, the site would provide a blast wall next to the table or litter that other medical staff can stand behind and be available for assistance or consultation. This location should be clearly established during the initial establishment of the treatment facility since it is difficult to identify and create a site in the midst of a patient with UXO impaled in their body. Avoid conducting this type of surgery in a confined space such as a contained bunker since the overpressure from a blast will only exacerbate the trauma from an explosion. Once the UXO has been removed, the patient can be moved to the main surgical facility to complete the operation.

X-RAY AND ULTRASOUND

Plain radiographs are generally considered safe with respect to potential inadvertent triggering of the UXO.[2] The patient should not be reoriented to obtain the films as any movement can inadvertently complete the arming or triggering mechanism and cause an explosion. The effects of ultrasound or CT scan on UXO are not documented in the literature.[4] Therefore; it is prudent to avoid these imaging modalities until studies confirm that they are safe.

SURGICAL INSTRUMENTS AND ADJUNCTS

Use of electrocautery, mechanical blood warmers, monitors, blood pressure gauges, infusers, or pumps should be minimized in order to reduce the risk of static electrical discharge.[5,6] Likewise, mechanical saws and drills that utilize electricity and pneumatics should be avoided in favor of non-powered manual saws due to concerns of discharge and vibrations.[6] In addition, surgical instruments, equipment, and supplies used for UXO surgery must be identified early on as part of the initial establishment or transfer of authority of a treatment facility. If available, these items should be placed in a container that can be rapidly moved to the ancillary surgical site. A list of items not in the container should be affixed to the top of the container so it can be collected Enroute to the ancillary surgical site. Do not use combustible agents in vicinity of patient (e.g., oxygen, alcohol-based solution, combustible volatile anesthetics).

OPERATING PERSONNEL

Personnel deemed not absolutely essential to achieve safe removal of the ordnance should be removed from the vicinity of the UXO.[7] Furthermore, all necessary equipment should be laid out in advance of the operation, eliminating the need for an OR technician whenever possible. A surgical assistant should only be used if it is absolutely necessary and the safe removal of the ordnance could not otherwise be accomplished. The UXO triage and operating team will vary from unit to unit and based on the specifics of the "impaled" ordnance. Each unit will need to identify who their primary UXO staff will be upon establishment of the treatment facility. This group of providers will need to periodically practice performing this task due to the complexities and stress involved.

Personnel typically volunteer to participate in these operations despite the significant danger. Final selection of the surgeon(s) to conduct the operation should be left up to the lead surgeon. It is imperative that the unit commander and the lead surgeon make every effort to limit the need for additional staff. This is done in order to minimize the risk to the surgical team, particularly in cases of mass casualties. Personnel participating in the surgery should gown and glove over ballistic protective equipment including safety glasses, helmet, and body armor with ballistic plates. An alternative approach is to perform UXO surgery while wearing an EOD bomb disposal helmet and suit (See Appendix B). This can be practiced in garrison and while deployed in collaboration with the local EOD unit. These suits have built in communications, heat-reducing technology, and are significantly better at protecting the entire body. All but the gloves can be worn providing protection to over 95% of the wearer's body.

ANESTHETIC CONSIDERATIONS

In most cases, general anesthetic will be used for these operations since it provides a more controlled environment.[7] For stable patients where the ordnance is impaled in an extremity, a nerve block is an acceptable alternative.[2] Use of supplemental oxygen during the operation to remove the ordnance should be limited in order to eliminate this additional combustible source. Ensure that the "D" size oxygen tank is behind the barrier, where the non-participating staff is located, to prevent it from exploding if the ordnance detonates. Consider having the anesthesia provider remote to the patient but able to view monitoring devices.

SURGICAL STRATEGY AND PRIORITIES

The guiding principle is to remove the ordnance by the most expedient means possible. This may require "en-bloc" resection of the tissue around the ordnance with amputation of the affected limb above the ordnance if this is deemed the quickest way to safely remove the ordnance. In general, impaled ordinance should be surgically exposed to a degree that will allow easy removal of the object in the same orientation as it lies in the body. Every effort should be attempted to avoid pushing forward or twisting the UXO during exposure or removal as this may set off triggering mechanism. Great care should be made to avoid banging or contacting the

ordnance with hands or surgical instruments. If ordnance is impaled into a limb, the extremity should be stabilized to avoid excessive vibration or movement that could complete the trigger. Simultaneous damage control operations for other injuries should be limited to life and or limb preserving operations. Delay definitive procedures until after the ordnance is safely removed. Once the UXO is removed, it should be gently handed off to an EOD expert or placed in explosive containment device. If the UXO placed in a containment device is in the vicinity of the patient, consider rapidly moving patient to safer location to complete procedure.

LATE FINDING OF UXO

Three of the six cases of impaled ordinance found in patients during the Global War on Terrorism were not recognized until the patient was in the OR. The impalement was unknown at the point of injury, transport, or initial evaluation by a Role 2 or Role 3 trauma teams since it was completely embedded in a body cavity or extremity with no exposed portions to alert the staff. The time and location when impaled UXO was initially recognized is not mentioned in previous reports. Intra-operative is not the ideal time to find the ordnance, but due to the nature of trauma and war wounds, this may be the case. Units must have a plan to address this. The core principles used in a known case of an impaled UXO should be followed. Minimal staff to remove the device is recommended, limit patient movement, and stop the use of medical equipment that may arm or detonate the device. The facility leadership and EOD team need to be notified as soon as possible. If the patient is stable, pause until EOD can confirm and identify the impaled device. Staff remaining to care for the patient should have their protective gear brought to them so they can don it rapidly. One of the biggest decisions is to stay within the facility or to relocate. This decision is complex and is dependent on multiple tactical and clinical factors. The medical treatment facility commander and senior surgeon must rapidly decide on the best course of action and ensure the safety of the staff while striving for survival of the patient. The goal is to care for the patient while preserving the personnel and equipment to care for current and future patients as well.

BIOLOGICAL AND CHEMICAL IMPALED UXO

While there are no documented cases of combat patients with loose or impaled UXO containing chemical or biological agents, it is conceivable that ordnance containing these agents could become impaled in a patient. Current doctrine states that it is a "command decision," on how to manage the patient.[1] However, it does not state if this is the local senior medical unit commander or local senior combatant commander that makes the decision whether to make the patient expectant or to provide full care. If the decision is made to provide full care and attempt to remove the agent containing UXO, individuals involved should be fully protected. All participating staff will need to wear available biological-chemical protective gear to include mask, body suit, boots, and gloves under their body armor if attempting to remove the ordnance. Ordnance containing chemical or biological agents usually has a much lower explosive force than traditional high-explosive or fragmentation ordnance to prevent destruction of the agents, and therefore the treating staff is at a lower risk of injury from a blast if the ordnance were to detonate. Therefore, there is more of a risk from contamination than blast when compared to a traditional high-explosive or fragmentation munitions. Agent containing ordnance should immediately be handed over to EOD followed by decontamination of the patient and medical staff when necessary before moving to the main treatment facility for further treatment.[1]

IMPALED UXO IN KIA PATIENTS

While the Armed Forces Medical Examiners System staff is unaware of any cases where a UXO was found impaled in a deceased US soldier since 2001, it has been reported in the world literature.[8,9] Since it has been recognized that many times the impaled ordnance is not identified until the patient is within a trauma treatment area of an MTF or in the OR, it again should be assumed that patients could die on the battlefield or in an MTF with unrecognized impaled ordnance. Therefore, it is recommended that all deceased individuals be screened

for impaled ordnance to prevent a catastrophic situation on the ground or in the air.[10] This can be accomplished by conducting a simple body cavity screening with a metal detecting wand, or an X-ray to include the torso, head, or injured extremities. If anything is found, the same precautions for a live patient should be taken to include having all nonessential people leave the threat area, notifying the local command, having security establish a perimeter, having EOD identify and remove the object, etc.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with retained ordnance

INTENT (EXPECTED OUTCOMES)

- EOD consult documented for all patients in population of interest.
- Treatment occurred outside of emergency room/operating room.

PERFORMANCE/ADHERENCE MEASURES

- Number and percentage of patients in population of interest with EOD consult documented.
- Number and percentage of patients in population of interest who are evaluated and treated outside of emergency room/operating room.

DATA SOURCE

- Patient Record
- DoD Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Director and PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A : TABLE OF UNEXPLODED ORDNANCE (UXO) PRACTICES

UXO Situational Practices
▪ Establish triage/search/blast contaminant area external to medical treatment facility (MTF) or establishment of facility.
▪ Upon discovery of UXO, immediately evacuate all non-essential personnel and move to a safe distance or protected one.
▪ Notify Explosive Ordinance Disposal team and local command authority.
▪ Using appropriate personal protective equipment, if possible move patient to a location separate from the MTF for evaluation and treatment.
▪ Minimize number of personnel involved in patient treatment, use of electrical equipment that may detonate UXO (e.g., electrocautery) and presence of additional combustible agents (e.g., oxygen, alcohol-based solutions, combustible volatile anesthetic agent).

APPENDIX B: UXO PERSONAL PROTECTION EQUIPMENT

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

How to Manage Mechanical Ventilation When Using the Universal Portable Anesthesia Complete Vaporizer, 26 Dec 2021

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Photos courtesy of Medical Photography, San Antonio Military Medical Center, Ft. Sam Houston, TX

I. Introduction

A. *This Clinical Practice Guideline (CPG) will clearly demonstrate in a step-by-step fashion the proper setup of the UPAC to each of the fielded ventilators, allowing anesthesia providers across all services to deliver safe, effective anesthesia to our warfighters.*

B. Anesthesia providers in Forward Resuscitative Surgical Teams (FRSTs) have relied on the Impact Uni-Vent Eagle 754 ventilator (Impact 754) to manage mechanical ventilation when using the Universal Portable Anesthesia Complete (UPAC) vaporizer. In support of modernizing forward surgical care, including the deployment of FRSTs, the military now fields new ventilators across the services. These ventilators include the Impact Uni-Vent 731 (Impact 731), HAMILTON T-1, and SAVe II. The Impact 731 and HAMILTON-T1 are the most readily available to FRSTs. While the SAVe II is available to some FRSTs, it is not recommended for long-term use and should only be used when other ventilators are not available. It is likely that many anesthesia providers have not worked with these new ventilators, and do not have the knowledge or access to reliable references/resources on the proper mating of the UPAC to a specific ventilator.

C. The CPG will follow a simple, easy to read format devoid of extraneous details. Each ventilator will have a section detailing complete start-to-finish setup of the UPAC to the ventilator. There will be detailed, labeled photographs with captions to assist the reader. Additionally, there will be troubleshooting tips at the end of each ventilator's section when applicable.

D. This CPG will serve as an invaluable resource to military anesthesia providers at home and abroad. There is no other known resource of its kind available to date, and it is a resource that can be easily adapted and utilized in the ever changing operational domain. The CPG will equip anesthesia providers with the knowledge and confidence to provide the highest quality care possible and assist our service members return to the fight.

II. UPAC Draw-Over Vaporizer

A. Standard equipment

Figure 1. Disassembled UPAC components. 1) UPAC case 2) UPAC vaporizer 3) Facemask 4) UPAC patient circuit tubing 5) Oxygen concentrator tubing and self-inflating bag tubing 6) T connector 7) Oxygen reservoir dust cap 8) Unidirectional E valve 9) Self-inflating bag 10) Oxygen tubing

Comments: Disassembled UPAC standard components

Figure 2. UPAC basic set

Comments: The UPAC vaporizer, UPAC patient circuit tubing, oxygen tubing, and facemask are known as the basic set. The basic set is required for use with each ventilator. Note that the oxygen concentrator and self-inflating bag tubing, T connector, oxygen reservoir dust cap, unidirectional E valve, and self-inflating bag from Figure 1 are not required items when using the UPAC with a ventilator. If positive pressure ventilation is needed without using a ventilator, use a separate self-inflating ventilation device (Ambu-bag) after disconnecting the patient from the UPAC-ventilator circuit.

Figure 3. Basic set with vaporizer oxygen inlet attached. 1) Supplemental oxygen connection.

Figure 4. UPAC vaporizer. 1) Vaporizer inlet 2) Concentration dial 3) Vaporizer outlet 4) Universal concentration chart 5) Supplemental oxygen inlet 6) Liquid anesthetic site glass 7) Fill port 8) Vaporizer stand

Comments: UPAC vaporizer details. When using the UPAC in a push-through configuration (as demonstrated in all four ventilator cases) the UPAC patient circuit tubing from the basic set is connected to the vaporizer inlet (Figure 4-1) and the standard ventilators' patient circuits are attached to the vaporizer outlet (Figure 4-3). C-clamps are also needed to secure the vaporizer stand to the work surface due to the top heavy nature of the vaporizer.

III. Impact 754 Ventilator

A. Required equipment

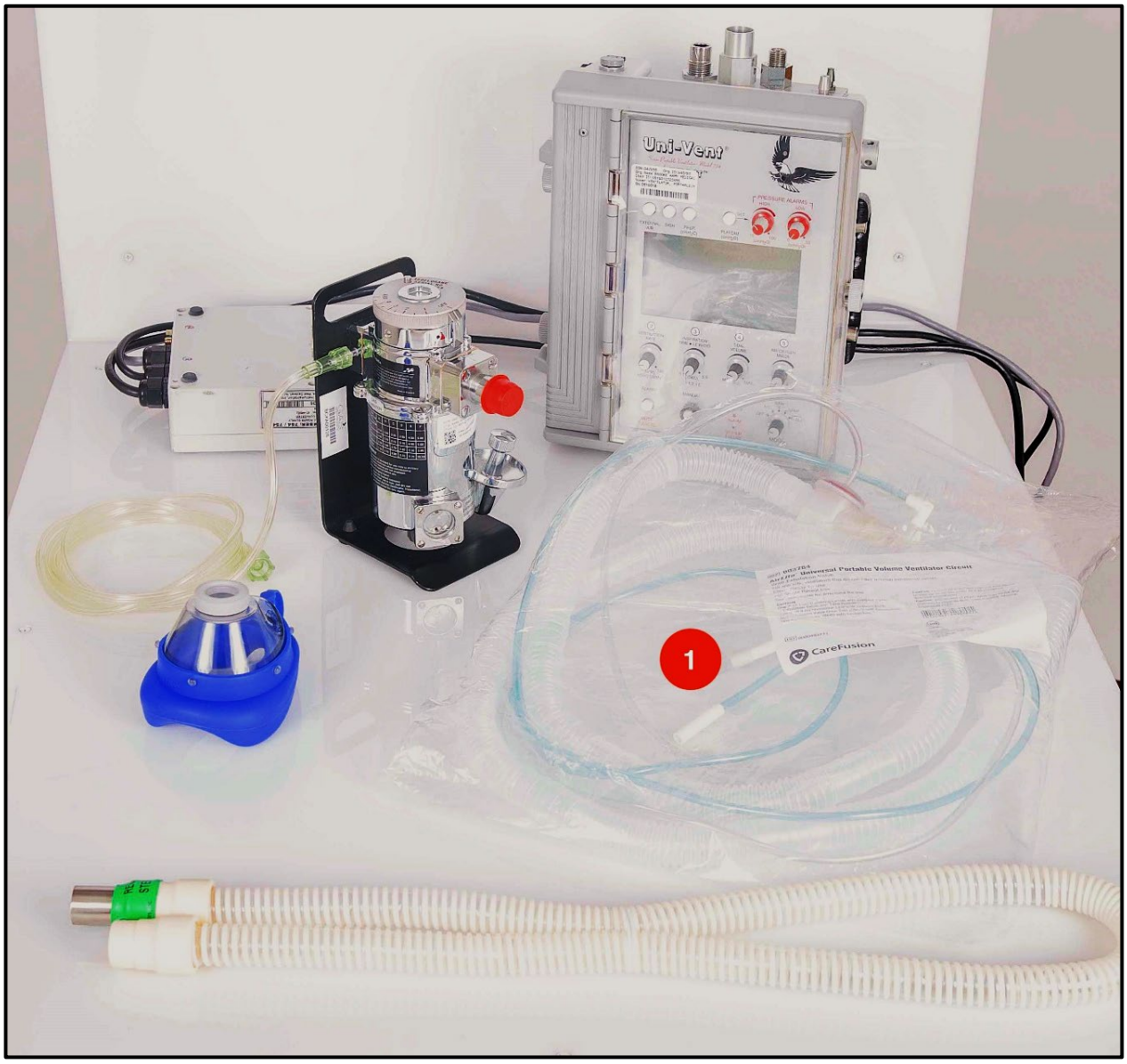


Figure 5. Impact 754 ventilator standard equipment set with patient circuit and UPAC basic set.
1) Patient circuit

Comments: The Impact 754 ventilator circuit will function with the Impact 731 and SAVe II ventilators.

Figure 6. Impact 754 power source. 1) Power connection for ventilator

Figure 7. Top view of Impact 754. 1) Attachment for standard circuit expiratory check valve 2) Attachment for standard circuit pressure transducer 3) Attachment for UPAC patient circuit tubing from the basic set

Comments: The UPAC patient circuit tubing from the basic set will connect to the vaporizer inlet (Figure 4-1).

Figure 8. Top view of patient connections for Impact 754. 1) Expiratory check valve tubing connected (clear tubing) 2) Pressure transducer tubing connected (blue tubing) 3) UPAC patient circuit tubing from the basic set

Comment: The pressure transducer tubing (blue) should be a different color than the expiratory check valve tubing (clear). The expiratory check valve tubing also has a textured collar at the end. If using

pipeline supply oxygen (55 psi standard) to the Impact 754, the auxiliary oxygen inlet on the UPAC (Figure 4-5) must remain occluded during use.

B. Connection to UPAC

Figure 9. Connection of UPAC patient circuit tubing from the attachment for UPAC patient circuit tubing from the basic set to the vaporizer inlet (Figure 4-1)

Comment: The UPAC patient circuit tubing metal-fitting end will connect to the vaporizer inlet.

C. Waste anesthetic gas scavenger setup

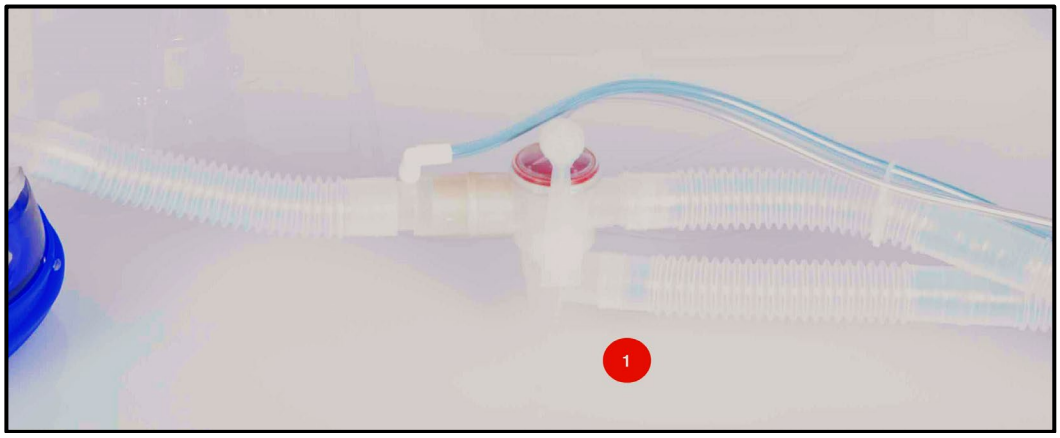


Figure 10 Waste anesthetic gas tubing connection to expiratory check valve of standard Impact 754 circuit. 1) Waste anesthetic gas tubing connection

Comments: Any standard diameter respiratory tubing (22mm female connection) will fit onto the swivel adapter directly beneath the expiratory check valve. This scavenger tubing should be routed out of the OR area, and *not* attached to any direct suction source (maintain passive waste anesthetic gas scavenging). Recommend using wire mesh or the standard UPAC dust cap (Figure 1-7) to prevent debris or insects from entering and occluding waste anesthetic gas tubing.

D. Full setup

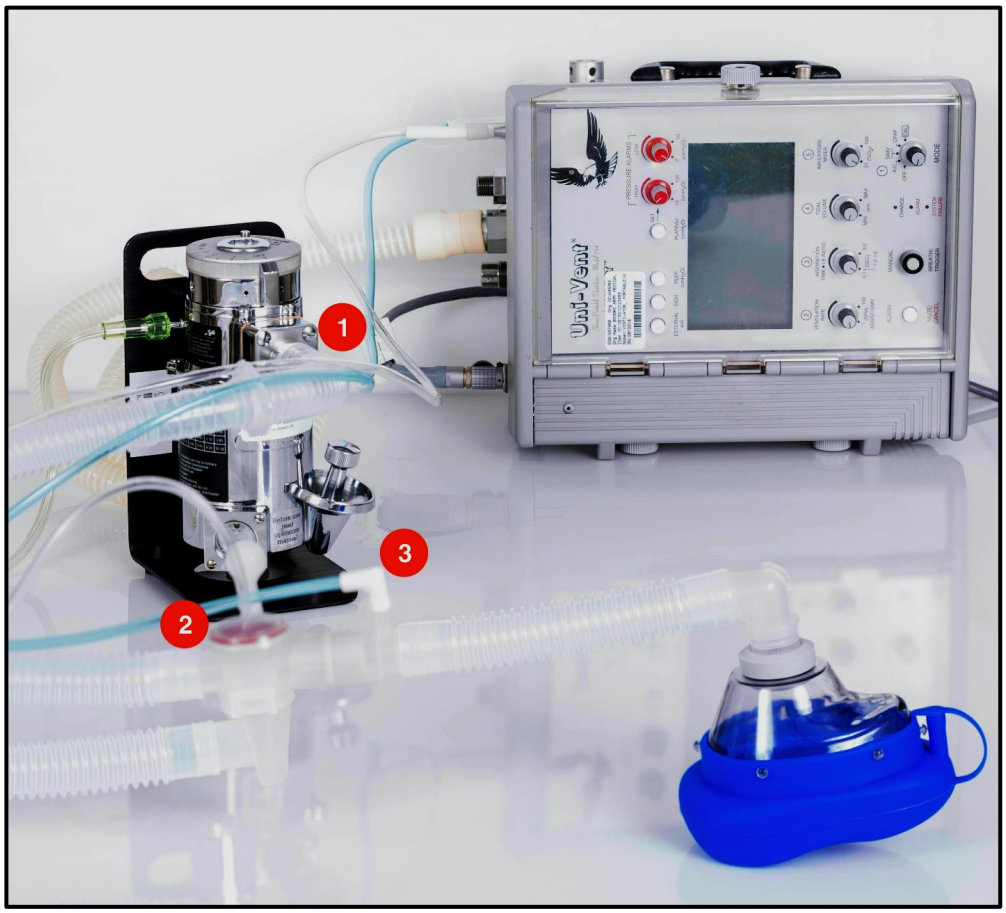
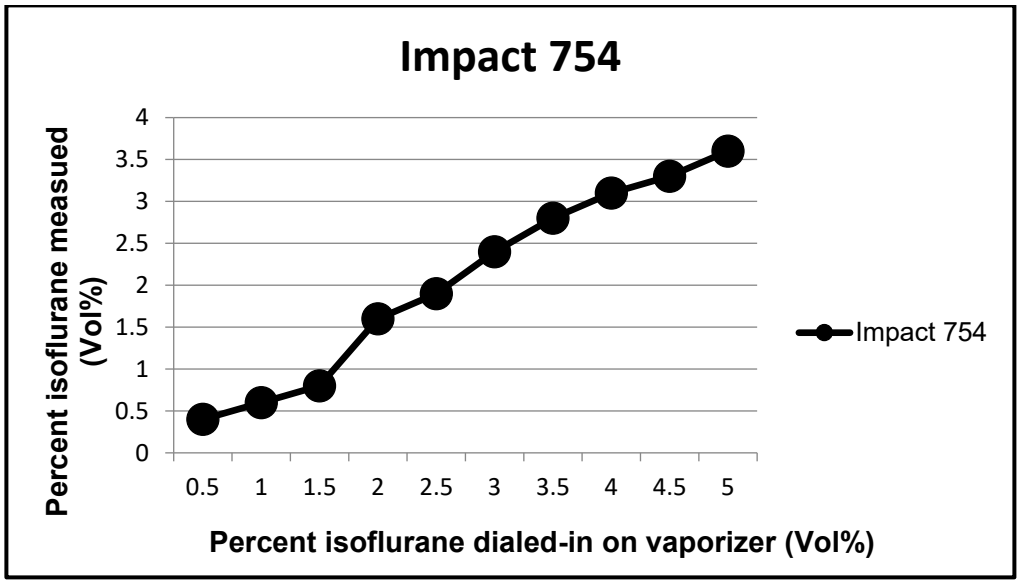


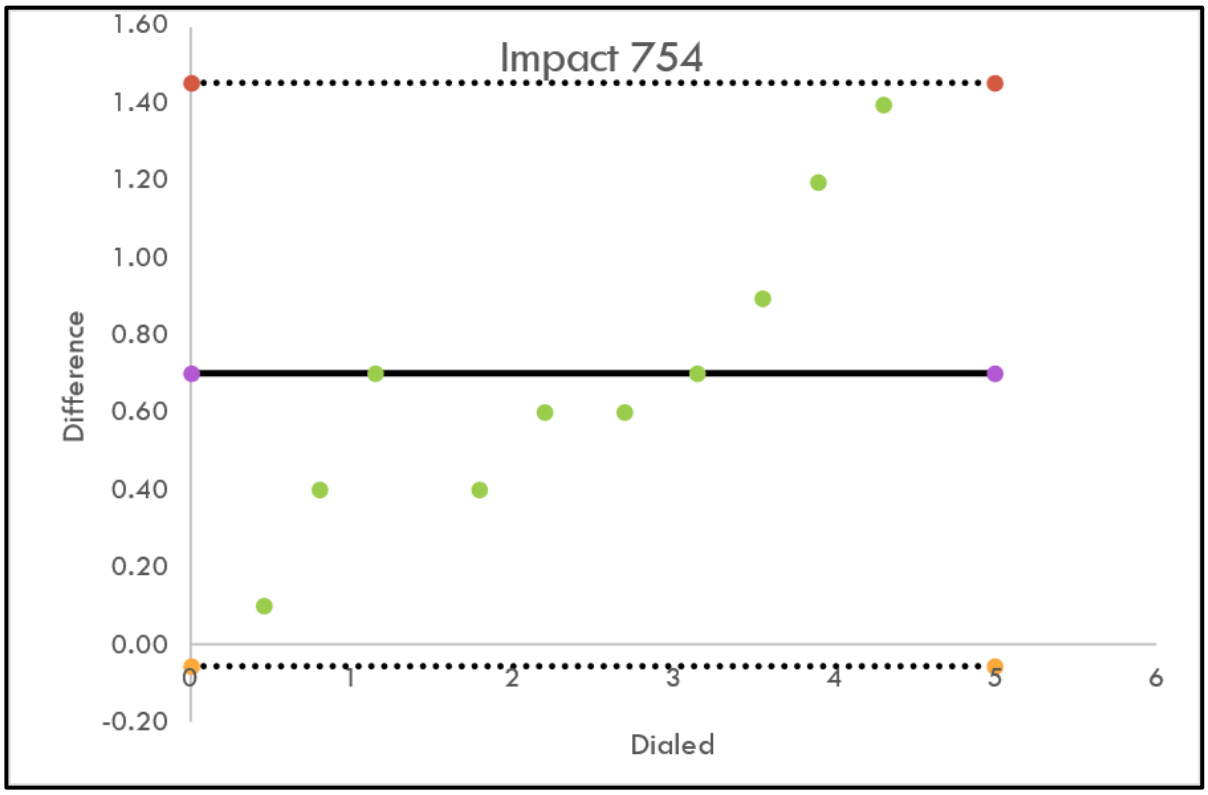
Figure 11. Complete setup of Impact 754 with UPAC. 1) Impact 754 circuit connected to UPAC outlet 2) Expiratory check valve 3) Pressure transducer

Comments: None

E. Expected UPAC vaporizer delivered agent concentrations (isoflurane shown)



F. Bland-Altman curve graph for isoflurane



G. Troubleshooting

Due to the limited visibility of the Impact 754 LCD screen, the use of a head lamp or flashlight is strongly encouraged. An external light source is not included in any discussed equipment set.

IV.Impact 731 Ventilator

A. Required equipment

Figure 12. Impact 731 ventilator. 1) Impact 731 2) Power cord 3) Standard Impact patient circuit and UPAC basic set

Comments: None

Figure 13. Top view of patient connections for Impact 731. 1) Power connection 2) Attachment for UPAC patient circuit tubing from the basic set 3) Attachment for standard circuit expiratory check valve 4) Attachment for standard circuit pressure transducer

Comments: None

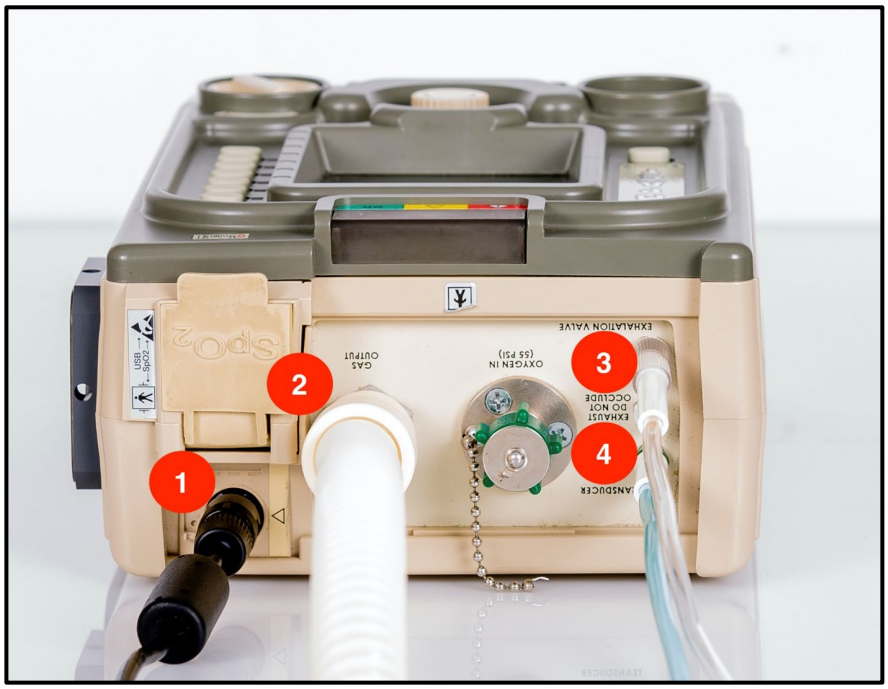


Figure 14. Top view of patient connections for Impact 731. 1) Power cord connected 2) Outlet connection to vaporizer via UPAC patient circuit tubing from the basic set 3) Expiratory check valve tubing connected (clear tubing) 4) Pressure transducer tubing connected (blue tubing)

Comments: As with the Impact 754, the pressure transducer tubing (blue) should be a different color than the expiratory check valve tubing (clear) on the Impact 731. The expiratory check valve tubing also

has a textured collar at the end. If using pipeline supply oxygen (55 psi standard) to the Impact 731, the auxiliary oxygen inlet on the UPAC (Figure 4-5) must remain occuded during use.

B. Connection to UPAC

Figure 15. Connection of UPAC patient circuit from the basic set (Figure 7-3) from the Impact 731 ventilator outlet (Figure 13-1) to the UPAC vaporizer inlet (Figure 4-1)

Comment: The UPAC patient circuit tubing metal-fitting end will connect to the vaporizer inlet.

C. Waste anesthetic gas scavenger setup

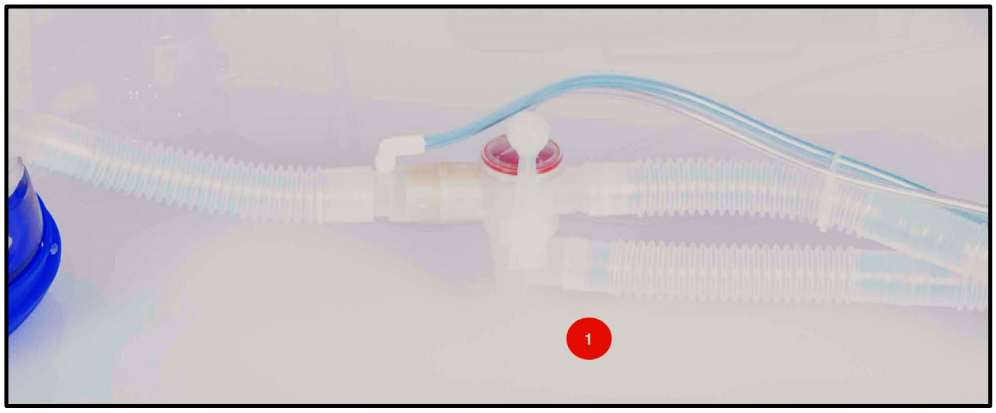


Figure 16. Waste anesthetic gas tubing connection to expiratory check valve of standard Impact 731 circuit. 1) Waste anesthetic gas tubing connection

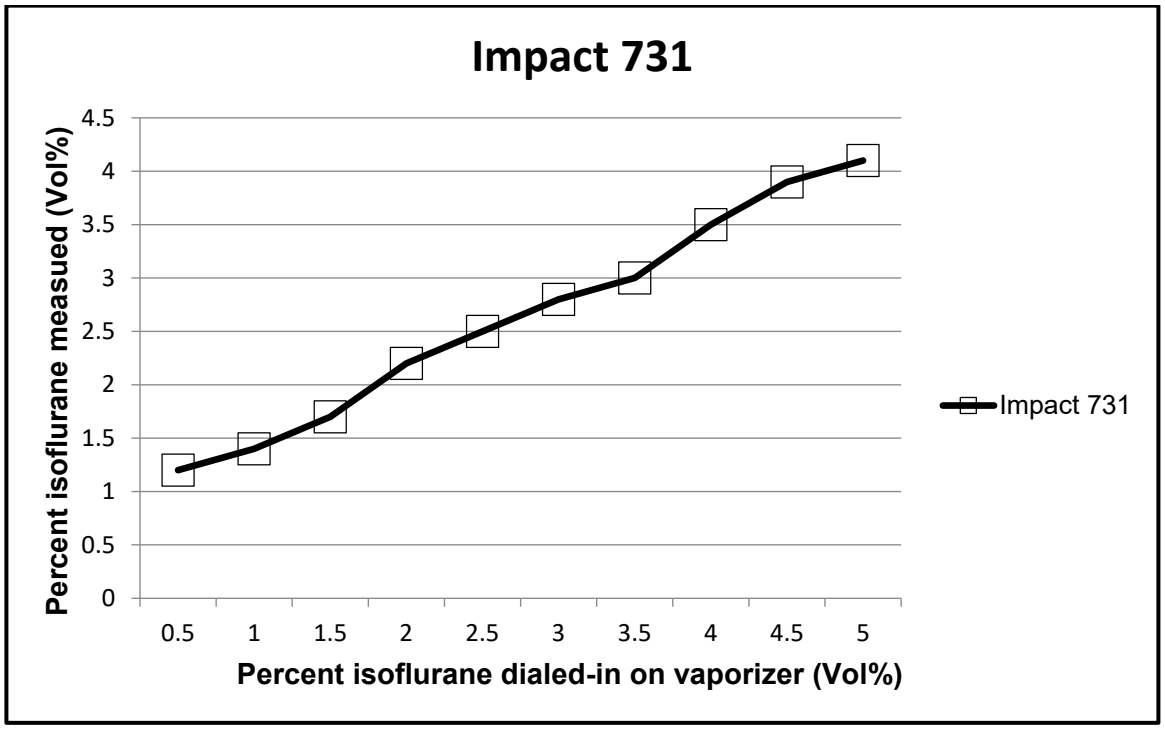
Comments: Any standard diameter respiratory tubing (22mm female connection) will fit onto the swivel adapter directly beneath the expiratory check valve. This scavenger tubing should be routed out of the OR area, and *not* attached to any direct suction source (maintain passive waste anesthetic gas scavenging). Recommend using wire mesh or the standard UPAC dust cap (Figure 1-7) to prevent debris or insects from entering and occluding waste anesthetic gas tubing.

D. Full setup

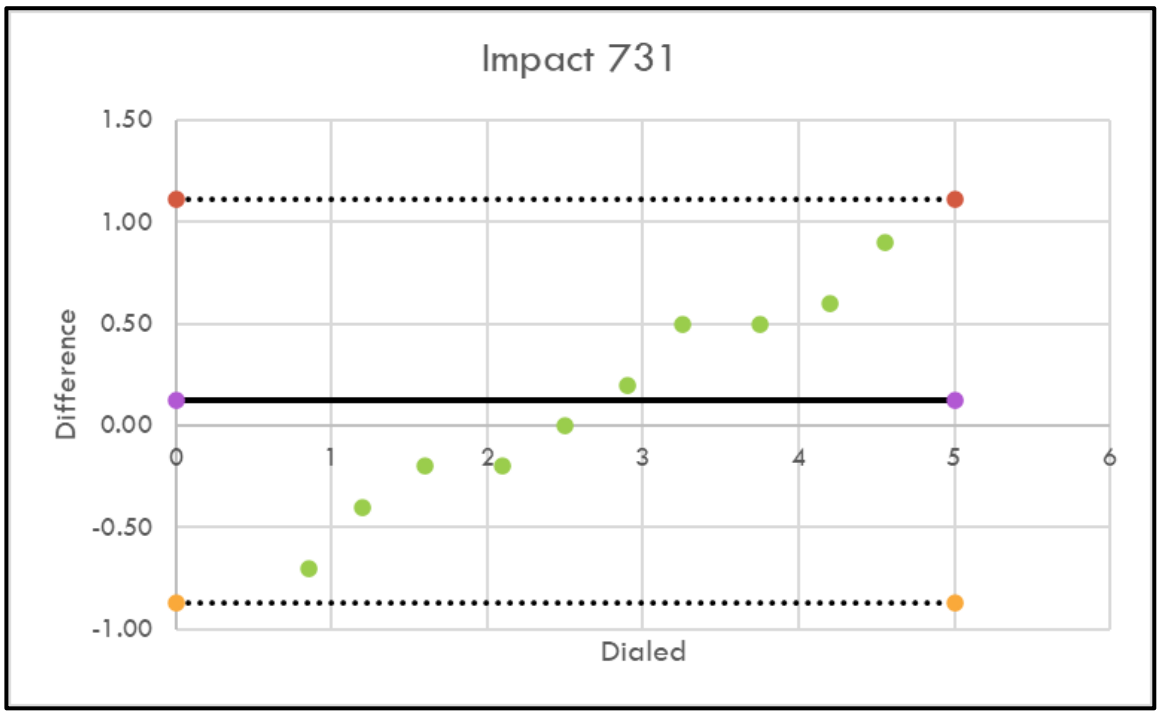
Figure 17. Complete setup of Impact 731 with UPAC. 1) Impact 731 circuit connected to UPAC outlet 2) Expiratory check valve 3) Pressure transducer

Comments: None

E. Expected UPAC vaporizer delivered agent concentrations (isoflurane shown)



F. Bland-Altman curve graph for isoflurane



G. Troubleshooting:

The standard circuits for the Impact 754 are completely compatible with the Impact 731.

V. HAMILTON T-1 Ventilator

A. Standard equipment

Figure 18. HAMILTON T-1 ventilator with standard patient circuit

Comments: Please refer to the HAMILTON T-1's operating instructions for pre-use checks and calibration.

B. Connection to UPAC

Figure 19. Side view of patient connections for HAMILTON T-1. 1) Outlet to UPAC 2) Inlet from patient

Comments: None

Figure 20. Expiratory valve diaphragm on ventilator circuit connection. 1) Expiratory valve diaphragm

Comments: The ventilator will not function if this valve is omitted before circuit assembly.

Figure 21. Side view of patient connections for HAMILTON T-1 with scavenger tubing. 1) HAMILTON T-1 outlet connection to UPAC via UPAC patient circuit tubing from the basic set 2) Input from patient expiratory limb of standard circuit 3) Expiratory check valve control connection (clear tubing) 4) Pressure transducer connection (blue tubing) 5) Scavenger tubing connected to expiratory check valve

Comments: The corrugated scavenger tubing is *not* included in the HAMILTON T-1 circuit. ***Respiratory tubing with a standard internal diameter of 22mm is needed to facilitate this portion of the setup.*** This scavenger tubing should be routed out of the OR area, and *not* attached to any direct suction source (maintain passive waste anesthetic gas scavenging). Recommend using wire mesh or the standard UPAC dust cap (Figure 1-7) to prevent debris or insects from entering and occluding waste anesthetic gas tubing.

Figure 22. Side view of patient connections for HAMILTON T-1 with expiratory tubing from HAMILTON T-1 standard breathing circuit to ventilatory expiratory check valve. 1) HAMILTON-T1 expiratory tubing

Comments: None

C. Waste anesthetic gas scavenger setup

Figure 23. Side view of scavenger tubing connection for HAMILTON T-1. 1) Scavenger tubing (Expiratory limb of HAMILTON T-1 standard breathing circuit omitted for emphasis on scavenger tubing connection.)

Comments: Due to the angle of the scavenger outflow, ***the right side of the HAMILTON T-1 ventilator should be elevated slightly to prevent kinking and occlusion of the scavenger corrugated tubing***. It is possible to attach one of the 90-degree elbows that are included with the HAMILTON T-1 set if the connection is wet with isopropyl alcohol in advance of assembly.

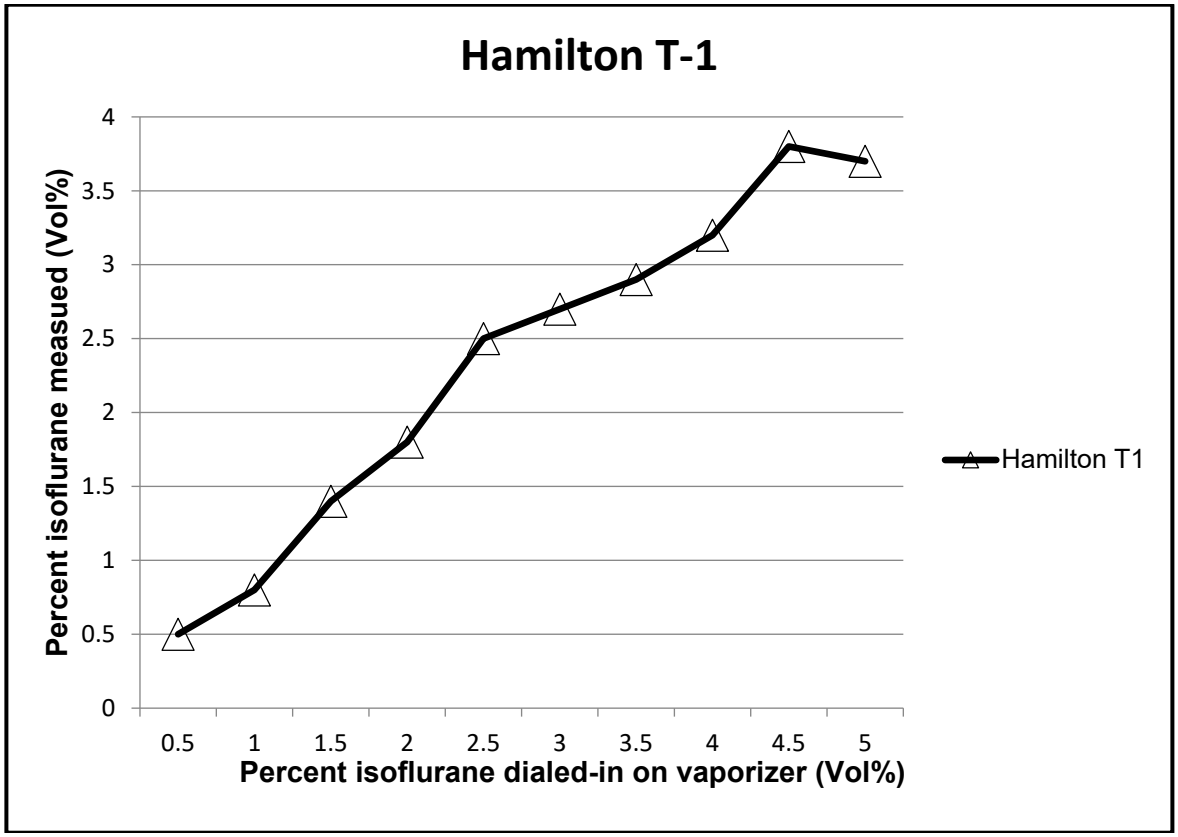
D. Full setup

Figure 24. Complete setup of HAMILTON T-1 with UPAC
Comments: None

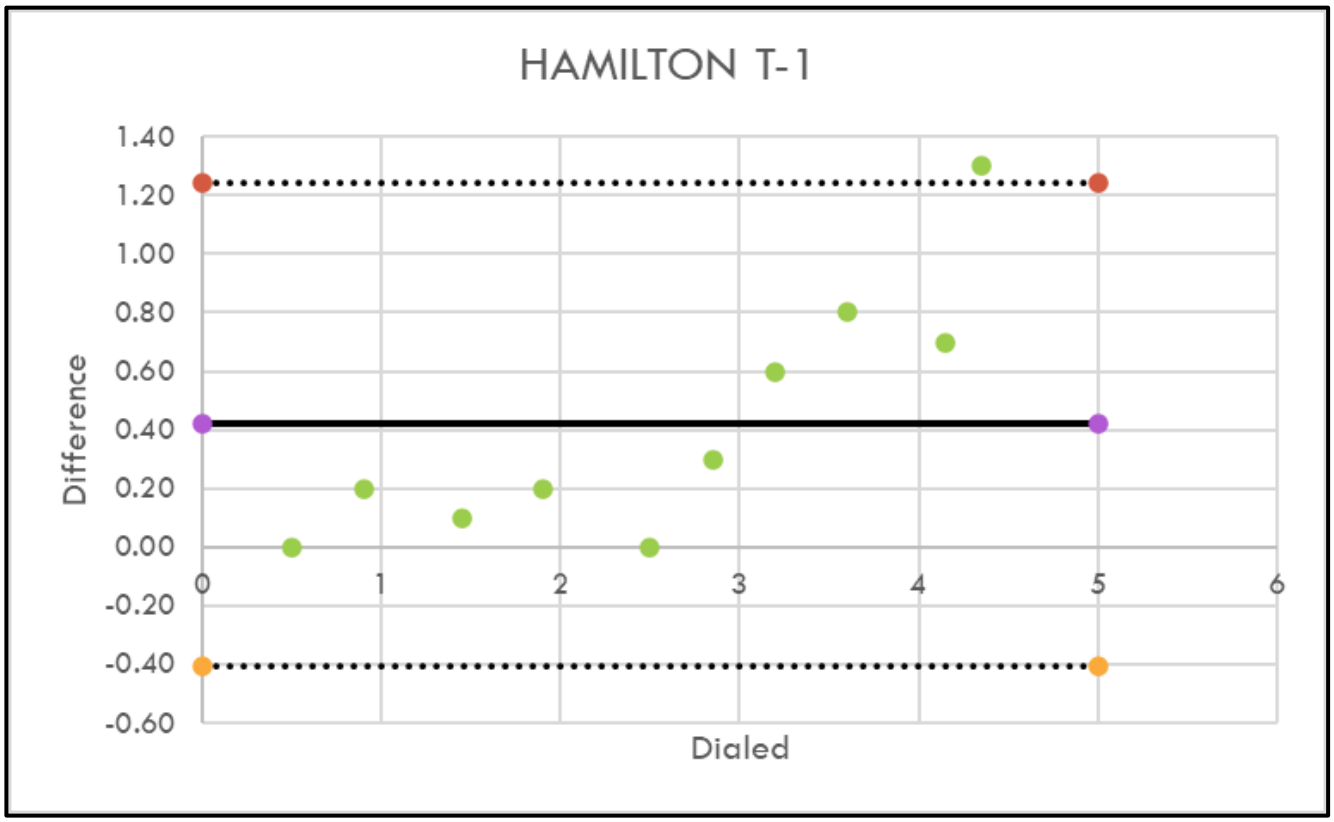
Figure 25. Side view of complete setup of HAMILTON T-1 with UPAC. 1) Bend and kinking of the scavenger tubing

Comments: Notice the bend and kinking of the scavenger tubing on the right side of the ventilator. ***The risk of scavenger and expiratory limb occlusion and barotrauma is relevant.***

E. Expected UPAC vaporizer delivered agent concentrations (isoflurane shown)



F. Bland-Altman curve graph for isoflurane



G. Troubleshooting:

Recommended best practice is to complete the pressure and flow sensor calibration sequence after complete assembly of the HAMILTON T-1 with the UPAC.

NOTE: Failure to complete these checks with the UPAC dial in the "off" position and the auxiliary oxygen inlet (Figure 3-1) on the UPAC occluded will result in a failed check error message on the HAMILTON T-1 screen.

VI.SAVe II Ventilator

A. Required equipment

Figure 26. Basic set and SAVe II ventilator. 1) UPAC corrugated tubing and scavenger tubing 2) SAVe II ventilator 3) Power cord 4) Standard circuit patient connection 5) Corrugated extension at patient connection

Comments: The scavenger tubing is not a standard tubing to the SAVe II.
***Long-term use of the SAVe II should be avoided in critical patients. It should only be used when other ventilators are not available.*

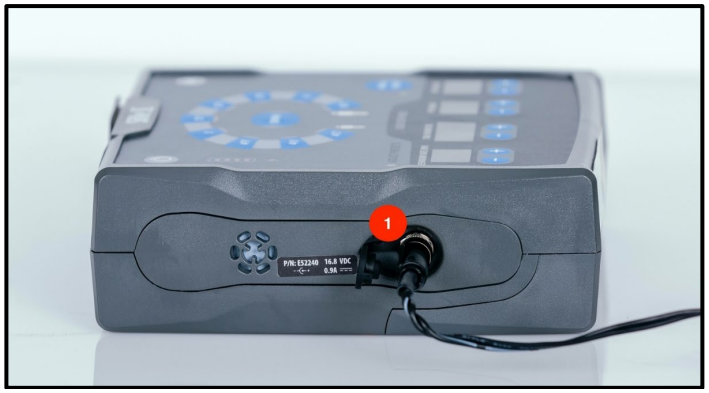


Figure 27 SAVe II ventilator power. 1) Power connection

Comments: None

Figure 28. SAVe II ventilator with standard patient circuit attached

Comments: The standard circuit from the Impact 754/731 has antectodal reports of compatability with the SAVe II.

Figure 29. Top view of patient connections for SAVe II. 1) Outlet connection to UPAC via UPAC patient circuit tubing from the basic set 2) Pressure transducer tubing (blue) 3) Expiratory check valve tubing (clear)

Comments: None

B. Connection to UPAC

Figure 30. SAVe II with UPAC connected

Comments: Note that scavenger tubing is not connected.

C. Waste anesthetic gas scavenger setup

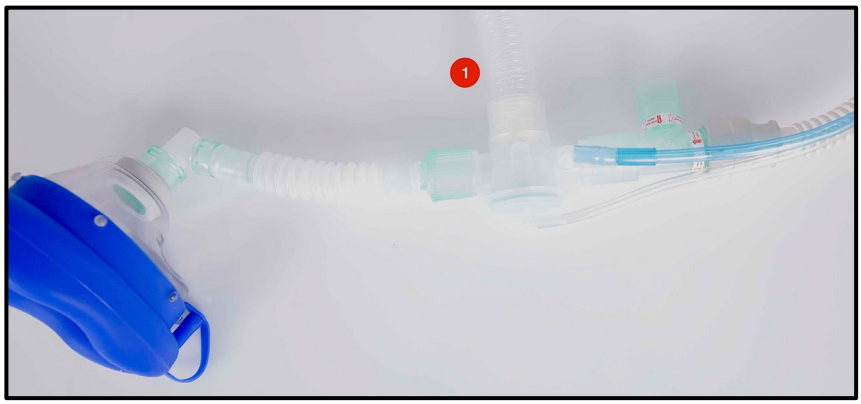


Figure 31. SAVe II standard circuit with corrugated tubing for scavenging connected. 1) Corrugated tubing for scavenging

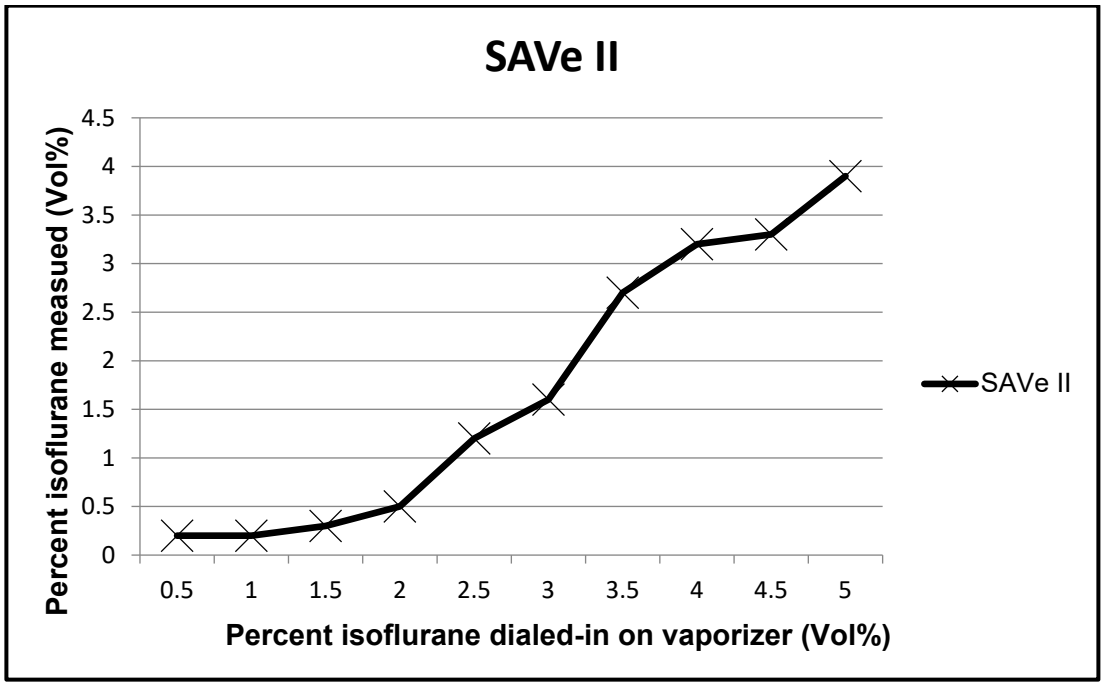
Comments: ***The outer diameter of the tubing must be increased by wrapping one-inch silk tape around one end in order for it to seat beneath the expiratory check valve of the SAVe II circuit.*** This scavenger tubing should be routed out of the OR area, and *not* attached to any direct suction source (maintain passive waste anesthetic gas scavenging). Recommend using wire mesh or the standard UPAC dust cap (Figure 1-7) to prevent debris or insects from entering and occluding waste anesthetic gas tubing.

D. Full setup

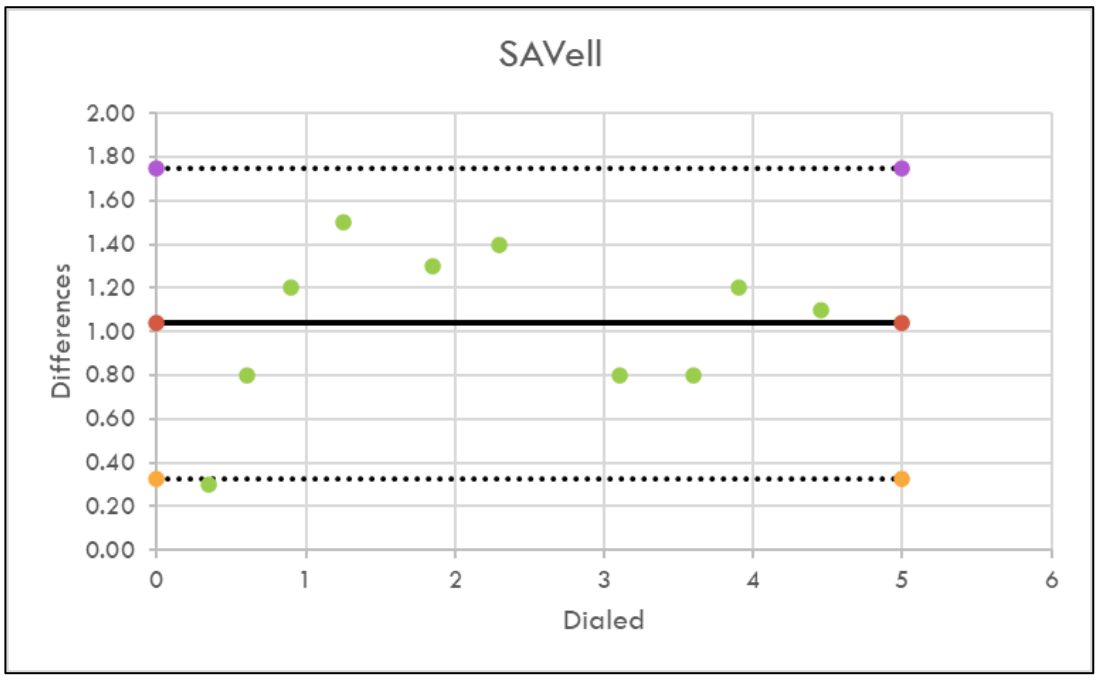
Figure 32. Complete setup of SAVe II with UPAC and scavenger tubing attached. 1) Scavenger tubing

Comments: The outer diameter of the tubing must be increased by wrapping one-inch silk tape around one end in order for it to seat beneath the expiratory check valve of the SAVe II circuit.

E. Expected UPAC vaporizer delivered agent concentrations (isoflurane shown)



F. Bland-Altman curve graph for isoflurane



G. Troubleshooting:

The noise from the compression chamber increases dramatically as tidal volumes and rates increase. Noise discipline as well as normal verbal communication will likely be compromised in these situations.

Appendix: Frequently Asked Questions about Managing Mechanical Ventilation and Using the UPAC Vaporizer in Deployed Settings

Purpose

This addendum serves to address frequently asked questions (FAQs) the authors received from anesthesia providers practicing in deployed settings.

FAQs

Q: Is the UPAC and mechanical ventilation setup meant for use during induction of a non-intubated patient?

A: No. The setup outlined in this CPG cannot serve as a substitute anesthesia machine and is meant for use post-intubation. If the provider wishes to use the UPAC during induction, they must use a self-inflating bag to provide manual ventilation to the patient and confirm endotracheal intubation. The provider must also emerge the patient using a self-inflating bag or by setting the ventilator on "spontaneous" (if available) and emerging with the UPAC in the "Off" dial position.

Q: Does the CPG address the use of the UPAC vaporizer in a pull-through configuration?

A: No, the current version of the CPG represents the use of the UPAC in a push-through configuration, meaning the ventilator pushes air and oxygen over the volatile agent in the UPAC for delivery to the patient.

Q: Why is the use of the UPAC in a pull-through configuration not discussed in this CPG?

A: While the Impact 731 and 754 have been used by multiple anesthesia providers in the pull-through configuration in deployed and training environments successfully, the effect of introducing anesthetic vapor into the impeller-driven compression chamber of the Hamilton T1 is unknown. Based on communication with the engineering branch at Hamilton Medical, using the T1 and UPAC in this configuration would be considered "off label use" by the manufacturer. Bench research studies are currently being designed to address this knowledge deficit, and will be relayed in a future addendum.

Q: Are there deployed transport ventilators that will preclude using the UPAC in a pull-through configuration?

A: Yes. The civilian version of the Hamilton T1, which has been furnished to deploying surgical teams lacks the air inlet fitting on the back of the ventilator (where an NBC filter could also be attached). Instead, there is simply a rectangular cutout to allow for air entry into the compression chamber of the T1 (see image below).

HAMILTON-T1 transport ventilator | Hamilton Medical (hamilton-medical.com)

This difference eliminates the 22mm fitting required to connect the UPAC patient outlet to the air inlet on the T1, as seen in the image below.

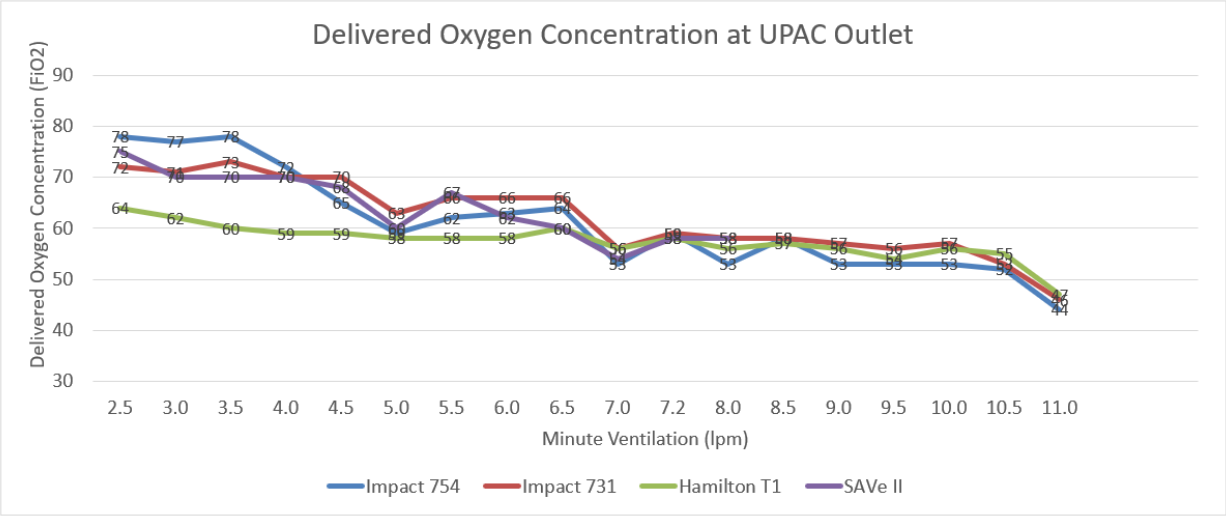
22mm NBC Filter Adapter. Author provided image.

Q: In what ways can supplemental oxygen be added to the delivered gases?

A: Low pressure oxygen, as delivered from a deployable oxygen concentrator, can be added via the supplemental oxygen inlet fitting on the side of the UPAC (see Figure 3 (1) in the above CPG) or the yellow oxygen inlet fitting on the circuit attachment side of the Hamilton T1. High pressure oxygen from a cylinder with a regulator can be attached via the diameter index safety system (DISS) fitting on the ventilators discussed in the CPG (except for the SAVeII).

Q: What are the FiO2 and flow limitations?

A: If the oxygen concentrator being used in a deployed setting has a maximum flow rate of 5 liters per minute, the delivered FiO2 will vary from a high of 0.78 FiO2 (78%) at a minute ventilation of 2.5 liters per minute to a low of 0.44 FiO2 (44%). These values are based on a recent bench research study's unpublished secondary analysis data. If higher flow rates are possible, these values will increase as well.



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JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Use of Traumatic Brain Injury Plasma Biomarkers after a Potentially Concussive Event (CPG ID:90)

Provides guidelines for use of plasma biomarkers in the evaluation of casualties with mild TBI (concussion) in a deployed environment.

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PURPOSE

These guidelines are intended to provide a basic management approach after a potentially concussive event using the specific plasma biomarkers for traumatic brain injury (TBI) on the iSTAT Alinity. This guidance does not apply to other brain injury devices or TBI biomarkers. This CPG is intended to complement and build upon the existing *DoD Instruction (DoDI) 6490.11 DoD Policy Guidance for Management of Mild Traumatic Brain Injury/Concussion in the Deployed Setting*.

BACKGROUND

- Between 2000 and 2019 TBI affected over 417,503 service members worldwide, with 88% of those injuries being classified as mild (mTBI), also known as concussion.[1] Common sequelae after mTBI include: headache, visual impairment, Post-Traumatic Stress Disorder (PTSD), depression and cognitive disorders; individuals with a mTBI are at increased risk of post-traumatic stress.[2-4] Secondary to these effects, only 70% of individuals diagnosed with mTBI return to full duty.[5]
- Individuals with mTBI typically have a normal (or negative) head CT. The purpose of head CT in an individual with suspected mTBI is to rule out a more severe injury requiring a higher level of care. For example, intracranial hemorrhage requires inpatient observation and, if severe, neurosurgical intervention. In civilian settings, approximately 6-8% of individuals with suspected mTBI at initial evaluation have evidence of intracranial hemorrhage and 1-2% require neurosurgical intervention.[6,7]
- CT scanners are typically available in theater at Role 3 facilities and select enhanced Role 2 facilities. The decision to transport a casualty from Role 1 or Role 2 to Role 3 for a head CT can have significant implications for the safety of the flight crew and mission accomplishment. Medical decision making should include an assessment of operational risk.
- An evaluation of the DoD Trauma Registry (DoDTR) suggests 68% of casualties identified as having mTBI were evacuated to the Role 3 for a head CT and 41% to Role 4, with approximately 78% of those Soldiers being returned to duty.[8] However, it is important to recognize the DoDTR only contains a subset of more severely injured Service Members with an mTBI in theater. Nonetheless, the data suggests that many evacuations for head CT may be avoided.
- The Military Acute Concussion Evaluation 2 (MACE2) provides guidance in the initial evaluation and management of individuals with (GCS score 13-15 in the deployed setting. It includes an assessment of "red flags" to determine the need for head CT and evacuation. In addition, the New Orleans Criteria and the Canadian Head CT rule also aid in identifying individuals most likely to benefit from head CT. None of these rules have been validated in the deployed setting.[9,10]
- Glial Fibrillary Acidic Protein (GFAP) and Ubiquitin Carboxyl-terminal Hydrolase L1 (UCH-L1) are contained within cells in the central nervous system and released upon neuronal damage. Higher levels indicate worsening neuronal injury.
- In January 2021, the U.S. Food and Drug Administration (FDA) approved a plasma biomarker for TBI, the i-STAT TBI Plasma Cartridge with the i-STAT Alinity System. This semi quantitative assay detects levels of GFAP and UCH-L1 in plasma. A facility with a lab section can perform the TBI plasma biomarker test. A result of "not elevated" on this test has a Negative Predictive Value approaching 100% for determining the absence of acute traumatic intracranial lesions on head

CT imaging. (See Appendix C Figure 1 for further information.) This assay is also known as the *Analyzer, Traumatic Brain Injury (ATBI) System.*

- Since this biomarker is performed on plasma, the test can only be used in a clinical laboratory setting with the capability to produce and test a plasma sample. Key logistical requirements include a centrifuge, refrigerated storage for cartridges, and frozen storage for calibration fluid. Ongoing product development efforts are focused on developing this into a test that can be performed on whole blood which will enable the use of the biomarker in a wider array of settings.

***NOTE**: Related clinical practice guidelines (CPGs): VA/DoD Clinical Practice Guideline for the Management of Concussion-Mild Traumatic Brain Injury, JTS Neurosurgery and Severe Head Injury*

STRUCTURE TO SUPPORT OPTIMAL USE OF TBI BIOMARKER

To minimize risks associated with use of this novel capability, we recommend a highly controlled rollout of the TBI biomarker. Each theater should restrict interpretation of test results and evacuation decisions to a select number of designated TBI biomarker consultants typically co-located at the Role 3. These individuals possess experience in evaluation, triage, and management of TBI in the acute setting and are knowledgeable in the clinical application of TBI biomarker values. The Theater Trauma Medical Director (TMD) is responsible for directing this overall effort but will normally yield clinical decision-making capacity to the neurosurgeon or other neurospecialist if available. Concurrent and standardized record-keeping using the Biomarker Data Collection Tool (Appendix D) is a must. This tool succinctly communicates mechanism, signs, symptoms, exam findings, TBI biomarker values, clinical decisions, evacuation priority, and concordant CT results or outcomes. The consultant is responsible for supporting the forward provider in execution of the TBI Biomarker Algorithm (Appendix A), use of TBI biomarker results, and disposition of the patient. When a negative TBI biomarker test guides a decision to keep the patient at the forward location, the consultant or TMD should remain engaged with that provider until no longer necessary. We recommend the consultants be responsible for completing the Biomarker Data Collection Tools. As the individual responsible for this TBI Biomarker Program, the TMD will ensure the Biomarker Data Collection Tools are submitted to Joint Trauma System (JTS).

INITIAL EVALUATION

Casualties should initially be evaluated and resuscitated based on JTS guidelines, Advanced Trauma Life Support (ATLS) principles, and Tactical Combat Casualty Care (TCCC) protocols after an acute injury, which may include a potentially concussive event (PCE). PCEs are defined in DoDI 6490.11 and include:

- involvement in a vehicle blast event, collision, or rollover;
- presence within 50 meters of a blast (inside or outside);
- a direct blow to the head or witnessed loss of consciousness; and
- exposure to more than one blast event.

The DoD classification of head injury as mild, moderate or severe includes the results of imaging and reports of symptoms for up to 7 days. Thus, for the purposes of initial evaluation in the field, the GCS is the most appropriate initial assessment and also has prognostic implications in the combat environment.

Head injured casualties are initially classified according to their GCS score:

- Mild: GCS 13-15
- Moderate: GCS 9-12
- Severe: GCS 3-8

***NOTE**: If the casualty has a GCS of 12 or less (moderate or severe TBI), please refer to the JTS Neurosurgery and Severe Head Injury CPG. This Biomarker CPG does not apply.*

If the casualty has no other injuries requiring evacuation, has a GCS of 13 or greater, and the TBI plasma biomarker test is not available, the MACE2 and Enclosure 3 of DoDI 6490.11 should guide initial evaluation in addition to these guidelines. (See Supporting TBI Resources for DoDI 6490.11)

This guidance and algorithm (Appendix A) expands upon the MACE2 and provides initial guidance for locations with access to the new TBI plasma biomarker test. The TBI plasma biomarker test should be used in the place of a "structural brain injury" device as listed on the MACE 2 under "red flags." However, it is important to note that this device does not provide a definitive diagnosis of a "structural brain injury" and it should be used and interpreted in accordance with the intended use statement in Appendix B. The MACE2 does not delineate which individuals should or should not undergo assessment with a structural brain injury device. This algorithm seeks to expand upon the MACE 2 to assist providers in understanding the most appropriate population for assessment with the TBI plasma biomarker.

RISK EVALUATION FOR BRAIN INJURY & INTRACRANIAL HEMORRHAGE

At locations with access to the TBI plasma biomarker test, a casualty exposed to a PCE should be stratified as high, moderate, or low risk using the Appendix A Algorithm. This is a modification of the MACE2, targeting the population most likely to benefit from the use of the TBI plasma biomarker.

HIGH RISK: DO NOT DELAY CARE FOR TBI PLASMA BIOMARKER

A subset of MACE 2 red flags suggest high risk of brain injury with intracranial hemorrhage. If any one of the following red flag signs or symptoms are present, the casualty should be referred urgently for CT scan. Do not delay evacuation to obtain TBI plasma biomarkers.

- Deteriorating levels of consciousness or a drop in post injury GCS score by 2 or greater
- Combativeness or agitated behavior
- 2 or more episodes of vomiting
- Witnessed seizure activity
- Focal neurologic deficits such as pupil asymmetry, facial weakness/asymmetry, weakness or paralysis on one side compared to the other
- Bleeding disorder or therapeutic anti-coagulation with heparin, low molecular weight heparin, warfarin, or novel oral anticoagulants (direct thrombin inhibitors and direct factor Xa inhibitors)

In addition, casualties with evidence suspicious for a penetrating brain injury, depressed skull fracture, or signs of a basilar skull fracture (e.g., raccoon eyes, battle's sign, otorrhea) should be referred urgently for CT scan.

MODERATE RISK: TEST TBI PLASMA BIOMARKERS BEFORE EVACUATION

This is the target population for TBI plasma biomarkers. Because of the significant false-positive rate, TBI plasma biomarker testing will be directed to casualties with moderate risk for intracranial hemorrhage. The goal is to allow symptomatic patients who test negative to forego CT scan and remain in place with activity restrictions (i.e. quarters, bed rest) and treatment of symptoms. There are two important caveats to this group:

1. The concussive event must have taken place within 12 hours of testing.
2. The patient should not have other injuries requiring urgent evacuation (fractures, concern for internal injuries, etc.). In this instance, testing should not hold up transport for more urgent issues, but can still be completed.

Casualties without the high risk red flag signs or symptoms described above but exhibit one or more of the following are appropriate candidates for TBI plasma biomarker testing.

- Double vision
- Increased restlessness
- < 2 episodes of vomiting
- Subjective weakness or tingling in arms or legs but no clear focal neurological deficit
- Severe, persistent, or worsening headaches
- Age >60 years
- Anti-platelet drugs (such as aspirin or ibuprofen)
- Drug/alcohol intoxication
- Post traumatic amnesia (inability to recall events for 30 or more minutes before injury)
- Worrisome mechanism of injury: high speed motor vehicle collision or rollover; fall from greater than 3ft; or presence within 50m of a blast inside or outside.

Casualties with any of these findings should be evaluated with the TBI plasma biomarker so long as the test is performed within 12 hours of the initial head injury. Then using the all the clinical details outlined on the Biomarker Data Collection Tool (Appendix D), the forward provider contacts the TBI Biomarker Consultant and the two come to a decision regarding need for head CT and priority of evacuation. When it is determined that the patient can remain in place with activity restrictions and be treated per the treatment section below, the forward provider and consultant should make a plan to communicate on the patient's progress.

LOW RISK FOR TBI: NO RISK FACTORS PRESENT

If the casualty does not have any of the risk factors described above, the provider should care for the casualty as described in the MACE2. If worsening symptoms develop more than 12 hours after the initial injury, the provider should contact the designated TBI Biomarker Consultant.

Research suggests that some casualties without MACE2 red flags undergo evacuation for head CT despite the MACE2 recommendations. If a provider wishes to obtain a head CT in individuals without the high or moderate risk signs or symptoms described above, a TBI plasma biomarker test should be

performed before referral for a head CT if the casualty is evaluated within 12 hours of injury. Consultation with the designated TBI Biomarker Consultant is strongly recommended to help determine the urgency of referral and evacuation.

LOCATIONS WITH ON-SITE HEAD CT

The TBI plasma biomarkers are a new capability both to the military and the civilian sector. As such, CPGs for the use of TBI plasma biomarkers have not yet been developed by civilian professional societies. When head CT capabilities are available on-site or evacuation is minimal risk, providers may consider performing both the TBI plasma biomarkers and head CT to gain additional experience with the TBI plasma biomarkers in clinical and operational settings. When this happens, it is imperative that a Biomarker Data Collection Tool is completed and forwarded to the consultant or TMD for the purposes of data collection on this emerging technology.

PRIMARY CONCUSSIVE BLAST

The TBI plasma biomarker was validated in civilian blunt trauma patients and it is unknown at this time how the test will perform in casualties sustaining mTBI from a primary blast wave exposure. This underscores the importance of data capture using the processes outlined in this CPG and submission of the Biomarker Data Collection Tool to JTS.

SYMPTOMATIC TREATMENT OF MILD TBI

The hallmark of treatment for service members who sustain an mTBI is relative rest and initial symptom management. Service members with mTBI should be managed in accordance with DoDI 6490.11 and the published DoD Traumatic Brain Injury Center of Excellence MACE 2 and Progressive Return to Activity Clinical Recommendation.

Many casualties with positive (elevated) results with TBI plasma biomarker will not have evidence of brain injury or intracranial hemorrhage on head CT but will have brain injury evident on Magnetic Resonance Imaging (MRI).[11] However, a TBI plasma biomarker result of “elevated” is not FDA approved for the diagnosis of mTBI and should not be used as the sole indicator of mTBI diagnosis; a clinical evaluation of the casualty is necessary to make a diagnosis of mTBI. At this time, it is not known whether casualties with positive (elevated) TBI plasma biomarkers but no evidence of injury on head CT should be treated differently from casualties with negative (not elevated) TBI plasma biomarkers. Therefore individuals with elevated biomarkers and a negative head CT should be managed as individuals with mTBI as per DoD guidelines cited in the preceding paragraph.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

Casualties exposed to a potentially concussive event.

INTENT (EXPECTED OUTCOMES)

1. Documented GCS, neurologic exams, MACE2 and symptoms for each service member exposed to a potentially concussive event.
2. TBI Plasma Biomarker performed on moderate risk patients within 12 hours of injury.
3. TBI Biomarker Consultant is informed on all positive and negative TBI Plasma Biomarker tests, resulting in completion of the Biomarker Data Collection Tool (Appendix D).
4. Biomarker Data Collection Tool is submitted/emailed to JTS: dha.jbsa.healthcare-ops.list.tbi-biomarker@health.mil

PERFORMANCE/ADHERENCE MEASURES

1. MACE2 exams documented on all Service Members diagnosed with mTBI
2. Documented results of the TBI plasma biomarker in the patient's medical record

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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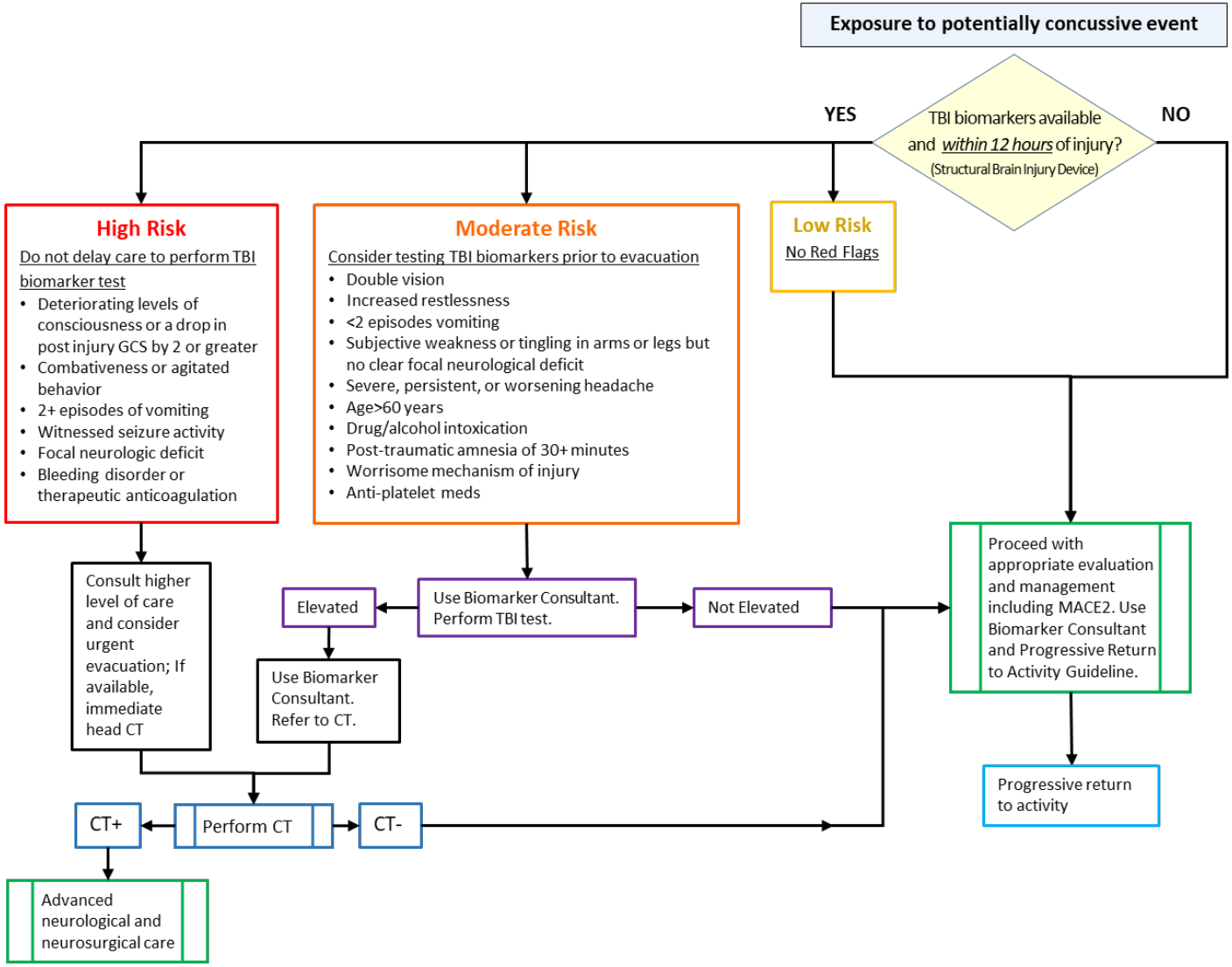
APPENDIX A: CLINICAL ALGORITHM FOR TBI BLOOD BIOMARKERS USE

Clinical Algorithm for Initial Management of a Potentially Concussive Event using the TBI Blood Biomarkers



APPENDIX B: DETAILED INFORMATION ON THE TBI PLASMA BIOMARKER

***NOTE**: Information summarized from Abbott Point of Care Inc., 2021, 510(k) Summary: i-STAT TBI Plasma Cartridge with the i-STAT Alinity System (K201778; Approved 8JAN2021). https://www.accessdata.fda.gov/cdrh_docs/pdf20/K201778.pdf.*

Capability Name: Analyzer, Traumatic Brain Injury System

Device Name: i-STAT TBI Plasma Cartridge with the i-STAT Alinity System

Device and Assay Description:

- Semi-quantitative multiplex immunoassay in ethylenediaminetetraacetic acid (EDTA) anticoagulated plasma for:
  - Glial fibrillary acidic protein (GFAP)
  - Ubiquitin carboxyl-terminal hydrolase-L1 (UCH-L1)
- Cartridge can only be used on the i-STAT Alinity.
- Will give an error reading if used on i-STAT 1.
- To separate plasma, blood requires processing in clinical laboratory settings with centrifuge capability.
- Cartridges require refrigerated storage; calibration/verification and control fluids require freezer for storage.
- Cannot be used as a point of care test in near patient settings; this may be possible for future products.

Assay Reference Range:

Range derived from n=225 apparently healthy individuals with no history of neurological disease:

- GFAP: Mean 19 pg/mL; Median 15 pg/mL; Reference Interval 2-51pg/mL (2.5th -97.5th percentile)
- UCH-L1: Mean 81 pg/mL; Median 71 pg/mL; Reference Interval 21-204 pg/mL (2.5th -97.5th percentile)

Assay Cut-Off Values and Results:

- Elevated: An elevated result is given if either GFAP OR UCH-L1 is elevated
  - GFAP cut-off: 30 pg/mL
  - UCH-L1 cut-off: 360 pg/mL
- Not elevated: A not elevated result is given if GFAP AND UCH-L1 are below the cut-off
- Not reportable: No result is given if valid results are below the cut-off AND one or more results are not reportable

Assay Performance

There were two studies performed as part of the U.S. Food and Drug Administration (FDA) licensure process.

***Study #1**: This study was conducted on stored plasma samples and demonstrated performance comparable to the Banyan Biomarkers assay with:*

- sensitivity of 95.8% [95% Confidence Interval (CI) 90.6%, 98.2%],
- negative predictive value of 99.3% [95%CI 98.5%, 99.7%], and
- specificity of 40.4% [95%CI 38.2%, 42.7%].

(See Appendix C for additional details.)

***Study #2**: This study was conducted on fresh plasma samples and demonstrated comparable sensitivity but lower specificity.*

- sensitivity of 100.0 [95% CI 88.3%, 100.0%],
- specificity of 23.7% [95%CI 14.7%, 36.0%].

(See Appendix C for additional details.)

Intended Use Statement

The i-STAT TBI Plasma test is a panel of in vitro diagnostic immunoassays for the quantitative measurements of GFAP and UCH-L1 in plasma and a semi quantitative interpretation of test results derived from these measurements, using the i-STAT Alinity Instrument. The interpretation of test results is used in conjunction with other clinical information to aid in the evaluation of patients, 18 years of age or older, presenting with suspected mild traumatic brain injury (Glasgow Coma Scale score 13-15) within 12 hours of injury, to assist in determining the need for a CT scan of the head. A "Not elevated" test interpretation is associated with the absence of acute traumatic intracranial lesions visualized on a head CT scan. The test is to be used with plasma prepared from EDTA anticoagulated specimens in clinical laboratory settings by a healthcare professional. The i-STAT TBI Plasma test is not intended to be used in point of care settings.

APPENDIX C: SUMMARY OF RESEARCH

Overall Summary of Evidence

Two studies were conducted in support of the FDA licensure request.[1] The first study used frozen plasma samples obtained from the study conducted in support of the Banyan Biomarkers TBI Assay.[2] This study (n=1901) demonstrated comparable performance to the Banyan Biomarkers assay with a sensitivity of 95.8%, negative predictive value of 99.3%, and specificity of 40.4% [95%CI 38.2%, 42.7%]. There were n=5 false negative test results; none of these were abnormalities requiring surgical intervention.[2]

The second study used a small sample of fresh plasma samples (n=88) obtained from a small subset of patients a study of TBI at Level 1 Trauma Centers who had head CT performed. In this sample the sensitivity and negative predictive value were 100%, but the specificity was lower - 23.7%. The reason for the lower specificity in this population is not clear but may have been due to the small sample size or due to differences in the study population. For example, only 6% of the population in the first study had findings on head CT as compared to this study where 33% had findings on head CT. The positive predictive values for the two studies were comparable after adjustment for the prevalence of positive head CT.

While the specificity of the assay is low to moderate for brain injury and hemorrhage visible on CT, additional research suggests that many individuals with elevated Glial Fibrillary Acidic Protein using a prototype of the assay have evidence of brain injury on MRI.[3] It is important to note the assay is not FDA approved for this purpose.[1]

Summary of Study #1

Stored frozen plasma samples were obtained from Bazarian, et al study used for approval of Banyan Biomarkers TBI assay, an early version of this assay.[1,2]

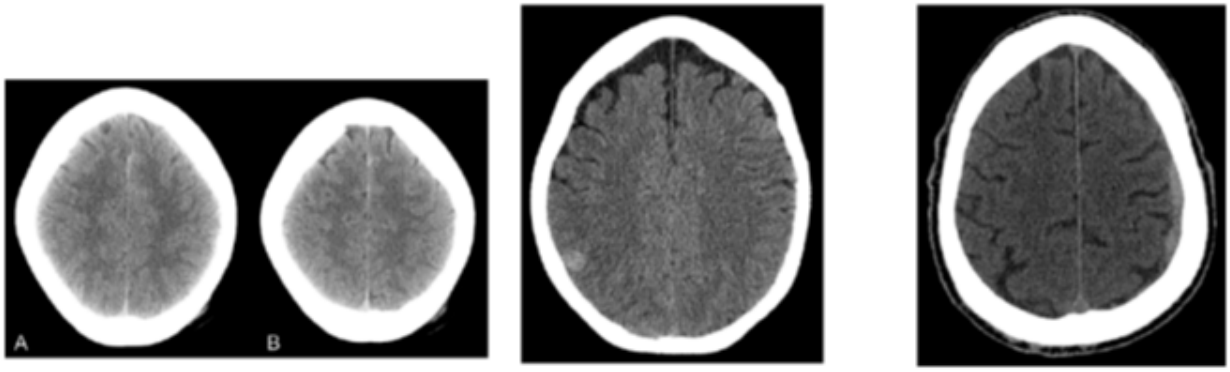
- **Inclusion/Exclusion Criteria**: Adults ≥18 years, presenting to Emergency Department with non-penetrating TBI and GCS 13-15, where the referring provider felt a head CT was indicated, with blood test within 12 hours of injury at 22 sites in the U.S. and Europe
- **The study population** (n=1901) had a median age of 49.0 years and ranged from 18 to 98 years. Over half (56.6%) were male and 70.6% were white and 26.2% were African American.
- Nearly all had a GCS of 15 (94.1%) and around half had Loss of Consciousness (42.2%), Alteration of Consciousness (56.3%), or visible trauma above the clavicle (63.3%). Around one-third reported post-traumatic amnesia (33.0%).
- The median time between injury and blood draw was 3.2 hours with a range of 0.3 to 11.9 hours.

Table 1. Clinical Performance

Clinical Performance			
i-STAT TBI Plasma Test Interpretation	Adjudicated CT Scan Result		Total
	Positive	Negative	
Elevated	115	1061	1176
Not Elevated	5	720	725
Total	120	1781	1901
Clinical Performance Parameters	N=1901	95% Confidence Interval	
Clinical Sensitivity	95.8%	90.6%, 98.2%	
Clinical Specificity	40.4%	38.2%, 42.7%	
Negative Predictive Value (NPV)	99.3%	98.5%, 99.7%	
Positive Predictive Value (PPV)	9.8%	9.2%, 10.2%	
Likelihood Ratio Negative (LRN)	0.10	0.04, 0.23	
Likelihood Ratio Positive (LRP)	1.61	1.15, 1.69	

- There were five individuals with false negative results (i.e. not elevated biomarker result and findings on head CT). None of these individuals required surgical intervention. Findings included a small sub-arachnoid hemorrhage, a small subdural hemorrhage and a venous angioma thought to be a congenital anomaly. See Figure 1 for 3 of the 5 head CT scans from false negative subjects.

Figure 1. Head CT Scans from false negative subjects



Legend: Left (subject 1) – Two non-contrast CT images (A + B) show focal subarachnoid hemorrhage in the anterior, paramedian frontal sulci. Middle (subject 2) – Non-contrast CT image shows a focal area of hyperdensity in the posterior right parietal lobe. On lower slices (not shown), there is a suggestion of some lower attenuation edema which marginates the contusion. Right (subject 3) – Non-contrast CT image shows subdural hemorrhage along the left lateral hemisphere, overlying the frontal and parietal lobes with minimal local mass effect on the brain parenchyma.

Summary of Study #2

Fresh plasma samples were obtained from four clinical sites of the *Transforming Research and Clinical Knowledge in Traumatic Brain Injury (TRACK-TBI) study* in the United States.[1,3]

- **Inclusion/Exclusion Criteria**: Adults ≥18 years, presenting to Emergency Department with GCS 13-15, who had a head CT performed at 4 sites in the U.S.
- **The study population** (n=88) had a median age of 42.5 years and ranged from 18 to 85 years. Nearly three-quarters (71.2%) were male.
- Most had a GCS of 15 (81.8%) and over half had loss of consciousness (68.2%), presence of confusion (67.0%), or post-traumatic amnesia (68.2%).
- The median time between injury and blood draw was 4.3 hours with a range of 2.0 to 11.8 hours.

Table 2. Clinical Performance – Supplemental Fresh Specimen Study

Clinical Performance – Supplemental Fresh Specimen Study			
i-STAT TBI Plasma Test Interpretation	Adjudicated CT Scan Result		Total
	Positive	Negative	
Elevated	29	45	74
Not Elevated	0	14	14
Total	29	59	88
Clinical Performance Parameters	**N=88**	**95% Confidence Interval**	
Clinical Sensitivity	100.0%	88.3%, 100.0%	
Clinical Specificity	23.7%	14.7%, 36.0%	
Negative Predictive Value (NPV)*	100.0%	80.2%, 100.0%	
Positive Predictive Value (PPV)*	39.2%	35.9%, 43.4%	
Likelihood Ratio Negative (LRN)	0.00	0.00, 0.50	
Likelihood Ratio Positive (LRP)	1.31	1.14, 1.56	

*Legend: *NPV and PPV estimated at 33.0% prevalence of CT scan positive rate for suspected mild TBI subjects. Adjusted NPV and PPV at 6% prevalence (to be comparable to the pivotal study) are 100.0% (95% CI: 96.9%, 100.0%) and 7.7% (95% CI: 6.8%, 9.1), respectively.*

Summary of GFAP/MRI Study

Yue JK, Yuh EL, Korley FK, et al. Association between plasma GFAP concentrations and MRI abnormalities in patients with CT-negative traumatic brain injury in the TRACK-TBI cohort: a prospective multicentre study. Lancet Neurol. 2019;18(10): 953-961. https://doi.org/10.1016/s1474-4422(19)30282-0

The study enrolled adults with GCS 13-15 between 2014-2018 at 18 participating Level 1 U.S. trauma centers who presented within 24 hours of injury and had a head CT as well as an MRI within 7-18 days post injury.[1,3]

- Of 1375 individuals enrolled in TRACK-TBI study, 794 had negative head CT and a GCS of 13-15 of whom 450 had an MRI scan performed within 7-18 days. Of these, 27% had positive MRI.
- Individuals with positive head CT had the highest GFAP levels (Median 786.0 pg/mL); followed by those with negative head CT and positive MRI (Median 414.4 pg/mL); followed by those with negative head CT and negative MRI (Median 74.0 pg/mL). Of note, healthy (Median 8.0 pg/mL) and orthopedic trauma (Median 13.1 pg/mL) controls had significantly lower GFAP levels (Table 3/Figure 2).
- From a pathophysiologic perspective, elevated GFAP levels were noted in traumatic axonal injury, diffuse axonal injury, extra-axial and mixed lesions (See Figure 2).
- The sensitivity and specificity of GFAP levels for positive MRI is listed in Table 4. Of note, GFAP levels greater than 282.70 pg/mL has a specificity of 80.3% for positive MRI.

Table 3. Plasma GFAP concentrations by imaging modality and findings

Plasma GFAP concentrations by imaging modality and findings					
	No of patients	Plasma GFAP concentrations (pg/mL)			
		Mean (SD)	Median (25-75th percentile)	Range	P value
Positive CT	199	1400.9 (1598.6)	786.0 (357.0-1863.3)	0-9409.7	<0.0001*
Negative CT	450	308.0 (530.5)	110.3 (22.7-352.3)	0-4095.1	..
Negative CT & positive MRI	120	692.2 (827.6)	414.4 (139.3-813.4)	5.2-4095.1	<0.00001†
Negative CT & negative MRI	330	168.3 (250.9)	74.0 (17.5-214.4)	0-1864.5	..
Orthopaedic trauma controls	122	23.7 (37.2)	13.1 (6.9-20.0)	0-216.8	<0.0001‡∫
Healthy controls	209	11.0 (12.7)	8.0 (3.0-14.0)	0-98.0	<0.0001‡∫

*GFAP=glial fibrillary acidic protein. P values were calculated from the Wilcoxon rank sum test for the comparisons, which compares the distributions of the two groups. *Compared with patients with negative CT. †Compared with patients with negative CT and negative MRI findings. ‡Compared with patients with negative CT and positive MRI findings. ∫ Compared with patients with negative CT and negative MRI findings.*

Appendix continued on next page.

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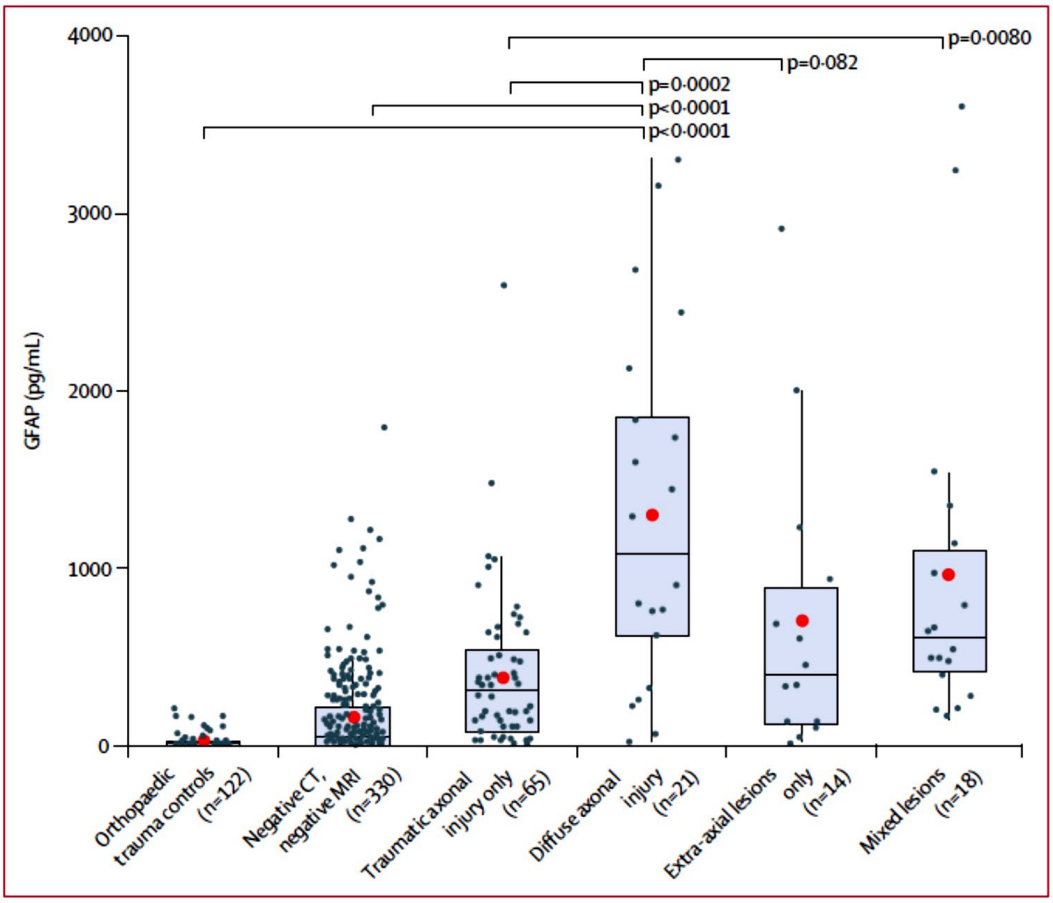
Figure 2. GFAP concentration by MRI pathology



The red dot signifies mean plasma GFAP concentration while boxplots provide range, median, and 25-75th percentiles. Individual dot values are plotted for reference. The Dunn Kruskal-Wallis test for comparisons among different MRI lesion types with a Benjamin-Hochberg correction for multiple comparisons[23] showed that GFAP concentrations are significantly higher in patients with isolated diffuse axonal injury than in those with isolated traumatic axonal injury. Separate Wilcoxon rank sum tests also showed significantly higher GFAP concentrations in patients with isolated diffuse axonal injury than in patients with negative CT and negative MRI findings, and orthopaedic trauma controls. P values are displayed for relevant comparisons. Two patients with isolated intracerebral contusions (GFAP 14.9 pg/mL, 285 4 pg/mL were not included as boxplot. GFAP=glial fibrillary acidic protein.

Table 4. Cutoff concentrations of plasma GFAP to predict MRI-positive versus MRI-negative findings in patients with negative CT

	Sensitivity	Specificity	NPV	PPV
4.40 pg/mL	1.000 (1.000-1.000)	0.024 (0.009-0.042)	1.000 (1.000-1.000)	0.271 (0.268-0275)
12.95 pg/mL	0.958 (0.925-0.992)	0.188 (0.148-0.230)	0.925 (0.863-0.981)	0.300 (0.287-0.313)
25.15 pg/mL	0.908 (0.850-0.958)	0.333 (0.288-0.388)	0.910 (0.861-0.957)	0.332 (0.312-0.354)
71.95 pg/mL	0.825 (0.750-0.892)	0.494 (0.442-0.549)	0.888 (0.845-0.924)	0.373 (0.344-0.407)
282.70 pg/mL	0.642 (0.558-0.733)	0.803 (0.758-0.842)	0.861 (0.832-0.890)	0.543 (0.482-0.603)
848.75 pg/mL	0.233 (0.158-0.308)	0.964 (0.942-0.982)	0.775 (0.760-0.793)	0.698 (0.555-0.842)

The k-fold cross validation method was used to select the optimal cutoffs for predicting MRI-positive versus MRI-negative findings in patients with negative CT based on the criteria of adjusted NPV above the level of 0·96, 0·94, 0·92, and 0·90, 0·85, and 0·80, in accordance to data standards for clinical laboratory assays set by the manufacturer. The prevalence of positive MRI scans among patients with negative CT scans was estimated to be 0·27 on the basis of the sample rate to calculate the adjusted NPV.1000 bootstraps were conducted to determine the optimal cutoffs using the median from each run. The optimal cutoff thresholds were than applied to the full data to calculate the corresponding sensitivity, specificity, NPV, and PPV. GFAP=glial fibrillary acidic protein. NPV=negative predictive value. PPV=positive predictive value.

APPENDIX D: BIOMARKER DATA COLLECTION TOOL

DOD ID: _____
Patient name: _____
DOB: _____

Requesting physician:_____
LATBI test location:
NIPR or SIPR phone:
Email:
Other contact info: _____

Local time of injury:_____
Date of injury: _____

Local time of blood draw: _____
Date of blood draw:_____

Clinical history (including *mechanism*)
Age:
Drugs/EtoH?
Mechanism:
☐ Blunt/Impact
☐ Blast
☐ GSW
☐ Other_____

Signs and Symptoms
☐ Headache (Severe? Persistent? Worsening?)
☐ Dizziness
☐ Memory problems
☐ Balance problems
☐ Nausea
☐ Vomiting (#of times____)
☐ Difficulty concentrating
☐ Irritability
☐ Visual disturbances
☐ Double vision
☐ Ringing in the ears
☐ Subjective weakness/tingling
– Location: _____
☐ Seizure
☐ AOC at time of injury – duration: _____
☐ LOC at time of injury – duration: _____
☐ Decreasing LOC or GCS?
☐ PTA at time of injury – duration: _____
☐ Other – describe: _____

Exam findings
GCS eye: _____
GCS motor: _____
GCS verbal: _____

High risk red flags
☐ Dec LOC or GSC drop ≥ 2
☐ Combative/agitated
☐ 2+ episodes vomiting
☐ Witnessed seizure
☐ Focal neurologic deficit
☐ Bleeding disorder/ anticoag(ulation)

Moderate risk red flags
☐ Double vision
☐ Increased restlessness
☐ 1 episode vomiting
☐ Subjective lateralizing neuro Sx, no focal deficits
☐ Severe, persistent or worsening headaches
☐ Age >60 years
☐ Drugs/EtOH
☐ PTA>30 minutes
☐ Worrisome mechanism
☐ Anti-platelet meds

Exam findings/comments

MACE results:
Cog: /30
Neurological:+ / -
Symptom: + / -
Hx: + / -
VOMS: + / - defer

Submit all pages of MACE2

LATBI test results
☐ Elevated
☐ Not elevated
☐ Invalid
GFAP: _____pg/mL
UCH-L1: _____pg/mL

Disposition (e.g. Admit/Qtrs/Profile/Duty):_____
- Evacuation? ☐ Yes ☐ No
  ☐ Routine ☐ Priority
- CT Scan findings: ☐ Negative ☐ Positive
- Describe injury type, location, volume:

Consultant name: _____
Consultant role: _____
☐ NSGY ☐ TMD ☐ Other: _____
Consultant notes:

Submit to: dha.jbsa.healthcare-ops.list.tbi-biomarker@health.mil

APPENDIX E: INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Vascular Injury (CPG ID: 46)

The CPG provides guidance on the diagnosis, treatment and surgical management of vascular injuries sustained by combat casualties.

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BACKGROUND

The treatment of vascular injuries in combat casualties can be a challenging endeavor in a resource limited environment and requires not only technical expertise on the part of the operating surgeon, but solid judgment on when to perform temporizing maneuvers versus definitive repairs. Surgeons at all Role 2 and 3 facilities need to be intimately familiar with the use of vascular shuts as a means to stabilize a critically wounded casualty and then move them along the continuum of care. With the evolution of global conflict, military surgeons at Role 2 facilities may be faced with potential obstacles to timely patient evacuation, or may be tasked to operate in an environment without an available Role 3 facility. They must also therefore be competent in the definitive surgical management of certain common and life or limb-threatening vascular injuries.

EPIDEMIOLOGY OF VASCULAR INJURY

The rate of vascular injury in modern combat is five times that reported in previous wars and one in five (20%) battle injuries (non-return to duty) are classified as hemorrhage control not otherwise specified suggesting the presence of significant bleeding. Using codes for specific blood vessel injuries or repairs, the rate of vascular injury is 12% in OIF and OEF, which is higher than the 1-3% reported in WWII, Korea and Vietnam.[1] Extremity vessels account for 70-80% of vascular injuries while 10-15% are in the cervical region and 5-10% in the torso.1-3 The widespread training and use of tourniquets in the modern battle field is likely one of the major reasons for the increase in vascular injuries seen. Casualties that would have died in the field in prior conflicts are now reaching medical care.

ECHELONS OF CARE AND VASCULAR INJURY

Each echelon has unique approaches to the management of vascular injury: [3]

- **Role 1** – Hemorrhage control (direct pressure, tourniquet or topical hemostatic agent) or other life-saving interventions and initiation of evacuation.
- **Role 2** – Operations at forward operating locations are abbreviated (<1 hour), however intervention on extremity vascular injury is important and may make the difference in meaningful limb salvage. Primary amputation or ligation is also an acceptable damage control technique when other life-threatening injuries are present or the patient is in extremis. However if limb salvage is to be attempted, initiation of basic maneuvers including removal of tourniquet, exploration and control of the vascular injury, removal of clot (thrombectomy) and administration of heparinized saline through the inflow and outflow vessels are recommended. Restoration of flow can then be established using a temporary vascular shunt followed by fasciotomy and initiation of medical evacuation. Temporary shunt placement for the initial management of proximal extremity vascular injury is associated with very high rates of successful limb salvage, and consistent shunt patency has been demonstrated for periods up to 12 hours.[4,5] However, experience with shunt utilization without systemic anticoagulation for more protracted periods is limited, and the risk of shunt thrombosis is markedly increased when used beyond 12 hours.[6,7] If a significant delay before definitive vascular management is anticipated, Role 2 surgeons should consider definitive management of the injury with repair/reconstruction or ligation, depending on the patient's stability and the experience level of the surgeon.
- **Role 3** – Removal of tourniquet(s) and any temporary vascular shunts placed at forward locations followed by definitive vascular repair using saphenous vein should be performed at this echelon. Synthetic PTFE conduit can be used in the absence of appropriate autologous vein. During aeromedical evacuation the extremity will be difficult to examine, therefore Role 3 surgeons must assure adequacy of limb perfusion, fasciotomy and wound debridement. Primary amputation or ligation is also an

acceptable damage control technique at this echelon of care when other life-threatening injuries are present or the patient is in extremis.

- **Overseas Role 4** – Surveillance of vascular repair including a close assessment of soft tissue wounds and adequacy of tissue coverage in the operating room prior to continuing MEDEVAC.
- **Continental United States (CONUS) Role 5**– Surveillance of vascular repair with duplex or CTA8 as well as assessment of soft tissue wounds and adequacy of tissue coverage is performed at this echelon. Angiography has particular utility in the identification of more subtle vascular injuries (e.g., traumatic pseudoaneurysm, arteriovenous fistula) following blast injury.[9] In some instances, revision of at-risk repairs identified as having a stenosis or inadequate tissue coverage leaving them prone to infection and blowout is necessary.[10] Finally, delayed revascularization of viable but poorly perfused extremities in which ligation was chosen as the initial method of management can be accomplished at this echelon.

DIAGNOSIS OF VASCULAR INJURY

1. **Hard signs such as hemorrhage, obvious ischemia, palpable thrill or expanding** hematoma require immediate management in the operating room, generally with exploration of the injury site with wide exposure to enable vascular control. Ischemia in this situation is defined as the absence of Doppler signal in the extremity on multiple attempts over time, including after initiation of resuscitation and warming. When hard signs of injury are present, there is limited need for other diagnostic tests (i.e. CTA or angiography) which take extra time and may provide findings which cloud decision making.[3,11,12]

2. **Soft signs such as history of significant hemorrhage, injury proximity to major vessels (fracture pattern, dislocation, penetrating wound or blast injury), bruising or hematoma** or question regarding the presence or absence of a palpable pulse require another diagnostic test. This additional test is commonly the continuous wave Doppler with calculation of the injured extremity index for traumatized limbs if possible and CTA or angiography for questionable torso and/or extremity vascular injuries where available.

3. **The injured extremity index** is similar to the ankle-brachial index and is calculated using a manual blood pressure cuff and a continuous wave Doppler. The first step is to determine the pressure at which the arterial Doppler signal returns in the injured extremity as the cuff is deflated, this is the numerator in the equation. Next the cuff and Doppler are moved to the uninjured extremity, ideally an uninjured upper extremity, and again the pressure at which the arterial Doppler signal returns as the cuff is deflated is recorded as the denominator in the ratio. An injured extremity index greater than 0.90 is normal and has a high specificity for excluding major extremity vascular injury.[13]

4. **Angiography has limited utility in the diagnosis of wartime extremity vascular injury** which is, in part, related to the availability and quality of imaging technology in austere environments. Additionally, extremity vasoconstriction associated with shock and hypothermia in the young injured patient may lead to confusing or false positive findings on angiography. Angiography has its greatest utility in the setting of multiple penetrating wounds at various levels of the same extremity and when performed should be done via a cut down on the femoral artery using a 19-21 gauge butterfly needle to inject contrast. In most instances it is acceptable to forego angiography and use an incision to expose the segment in question with the plan to ligate, shunt or repair the vascular injury.

5. **Computed Tomography-Angiography (CTA)** is increasingly available in a mature theater of war and has its greatest utility in the diagnosis and triage of torso and neck wounds. Reports of CTA for evaluation of extremity vascular injury now exist; however this modality should be viewed as an adjunct, as its full utility has yet to be determined. Specifically, CTA for head and neck wounds demonstrates a sensitivity

of 80%.[14,15] Furthermore, this modality takes additional time, IV contrast and technical experience in order to provide accurate and meaningful images.

GENERAL PRINCIPLES OF VASCULAR INJURY MANAGEMENT

Most deploying non-vascular or non-cardiothoracic surgeons will have limited recent experience in vascular surgery. Prior to deployment, training for surgeons should emphasize the basic principles of vascular trauma management, including adequate exposure, proximal and distal control, vessel debridement to viable tissue, the creation of a tension-free anastomosis, repair or shunt, and adequate coverage with viable tissue. The most challenging aspect in the management of a wartime vascular injury is generally related to vascular exposure. As most of these injuries involve previously normal blood vessels, vessel suturing and shunt placement are usually a relatively straightforward technical exercise. However, in the face of tissue destruction, hematoma, distorted anatomic landmarks, and the potential absence of a palpable pulse, the identification and adequate exposure of a wartime vascular injury can be a challenge for even an experienced surgeon. While the deploying surgeon will find the techniques and "pearls" in Appendix A and Appendix B extremely valuable for pre-deployment review and as a reference during deployment, surgeons should also maximize opportunities to review anatomic exposures in cadaveric, simulation, and video settings prior to deployment. Furthermore, an atlas that covers vascular surgery and exposures should be at the immediate ready for every surgeon on a combat deployment.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

- All patients with penetrating injury to an extremity proximal to knee/elbow with AIS ≥ 2 or diagnosis of posterior knee dislocation.
- All patients diagnosed with injury to major artery or vein (subclavian, axillary, carotid, brachial, common femoral, superficial femoral, popliteal, common iliac, external iliac, internal iliac, aorta, vena cava, portal vein, hepatic artery, mesenteric artery, renal artery).

INTENT (EXPECTED OUTCOMES)

1. All patients with penetrating injury to an extremity proximal to knee/elbow with AIS ≥ 2 or diagnosis of posterior knee dislocation have injured extremity index documented.
2. All patients with penetrating injury to an extremity proximal to knee/elbow with AIS ≥ 2 or diagnosis of posterior knee dislocation have neuro and vascular exam documented.
3. All patients diagnosed with injury to major artery or vein undergo revascularization (shunt or repair) or ligation at the first surgical capability (or valid explanation for delay documented) prior to transfer to next level of care.
4. All patients diagnosed with injury to major artery or vein who undergo reperfusion (shunt or repair) have the procedure within 4 hours of injury.

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest who have injured extremity index documented.
2. Number and percentage of patients in the population of interest who have neuro and vascular exam documented.

3. Number and percentage of patients in population of interest who undergo revascularization (shunt, repair, ligation) prior to transfer to next level of care.

4. Number and percentage of patients in population of interest who injury undergo reperfusion (shunt or repair) or ligation within 4 hours of injury.

DATA SOURCE

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Chief and the JTS Performance Improvement Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local echelon with this CPG

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APPENDIX A: EXTREMITY VASCULAR INJURY

NOTE: *See Figure 1. Algorithm for Extremity Vascular Injury*

UPPER EXTREMITY

Subclavian Artery

- Recommendations: Repair
- Utility of temporary shunt: Low
- Method/ Conduit: Interposition graft /6-8mm ePTFE or Dacron

Pearls

- Proximal right subclavian is approached through median sternotomy and the proximal left subclavian through a high left anterolateral thoracotomy
- The supraclavicular approach is through the clavicular head of sternocleidomastoid muscle and scalene fat pad with retraction of phrenic nerve and division of the anterior scalene muscle
- Place gentle role under shoulders and extend head away from side of injury

Avoid injury to phrenic nerve, brachial plexus and vertebral arteries. The proximal left subclavian artery is approached using a high (3rd intercostal space) anterolateral thoracotomy and the innominate and proximal right subclavian artery through a median sternotomy and supraclavicular incision. The innominate vein can be ligated and divided to facilitate exposure to the innominate artery. Alternatively, the mid and distal subclavian arteries on both sides can be exposed through a supraclavicular incision or combined supraclavicular/infraclavicular incisions. There is no requirement to obtain proximal vascular control within the surgical field of injury; using separate incisions through non-traumatized tissues can expedite rapid vascular control. When approaching this injury the operator should err on the side of ample proximal exposure and if necessary, can resect the clavicular head. In an unstable patient it is recommended that initial proximal control be obtained via thoracotomy as this will allow for more rapid control than use of the supraclavicular approach. Because of the technical challenges with exposure, the utility of temporary vascular shunts in this injury pattern is limited. Most often interposition graft using 6-8 mm ePTFE or Dacron is required for subclavian artery repair, being mindful of the vertebral artery and the phrenic nerve. If endovascular capability is available, balloon occlusion of the proximal subclavian artery can be a useful adjunct, and repair with a covered stent can be considered. [2,6]

Axillary Artery

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Interposition graft/ reversed saphenous vein

Pearls

- Supra- and infraclavicular incisions allows proximal control and distal exposure.
- Prep axilla, arm and hand of upper extremity into operative field.
- Avoid brachial plexus which will be deep or lateral to axillary artery.

Control of the proximal axillary artery is best accomplished through a supraclavicular incision, although the artery itself is exposed through an infraclavicular incision extending into the axilla. The infraclavicular exposure

includes division of the clavipectoral fascia, and the blunt separation of the fibers of the pectoralis major muscle for entire the length of the wound. The axillary vein is the first structure to be encountered in the axillary sheath. The axillary artery lies superior and deep to the vein, mobilization and caudal retraction of the axillary vein will expose the first segment of the axillary artery. The first segment of the axillary artery is then visible coursing under the pectoralis minor muscle which can be retracted laterally or divided. It is important when exposing the artery to have the arm and hand prepped in the operative field and extended out onto an arm board. Repair of the axillary artery most commonly involves an interposition graft using reversed saphenous vein.

Brachial Artery

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Interposition graft/ reversed saphenous vein

Pearls

- Medial approach; adjacent to the median nerve in brachial sheath in bicep/triceps groove.
- Elastic artery with redundancy; flex arm slightly for interposition grafts to avoid kinking.
- Depending upon damage to collaterals, distal ligation (below profunda brachial or deep brachial artery) may be tolerated.

The brachial artery with the median nerve rests in the brachial sheath and is exposed through a medial incision in the upper arm in the groove between the bicep and triceps. The median nerve is the most superficial structure encountered upon entering the brachial sheath. The ulnar nerve runs posterior to the artery which is surrounded by paired deep brachial veins. A common anatomic variant is for there to be a high bifurcation of the brachial artery in the upper third of the arm. Repair is most commonly accomplished using a reversed saphenous vein interposition graft. Although it may be possible to ligate the brachial artery below the origin of the deep (profunda) brachial artery and maintain a viable arm and hand, this proposition is based on intact collateral circulation. Unfortunately collaterals from the shoulder and deep brachial artery are often damaged in the setting of penetrating blast wounds and therefore maintenance of flow through the brachial artery with a temporary shunt or vascular repair is advised. Ligation or primary amputation is an acceptable damage control maneuver if there is not time for shunting or the patient is in extremis.

Radial/Ulnar Arteries

- Recommendations: Selective (repair some but not all)
- Utility of temporary shunt: Low
- Method/ Conduit: Ligation or interposition graft/ reversed saphenous vein

Pearls

- The presence of an arterial Doppler signal in the hand obviates the need for artery repair.
- Repair with saphenous vein in instances where the absence of an arterial signal persists.

Most often the hand has a dual arterial supply and therefore can tolerate ligation of either the radial or ulnar artery. As such, repair or reconstruction of an injury at this level is rare. Perfusion to the hand should be assessed with Doppler before and after occlusion or ligation, and if the absence of a signal persists, reconstruction with reversed saphenous vein should be performed. Given the relative small muscle mass of the

hand and the degree of collateral circulation, ligation is most often tolerated understanding that if ischemia persists, evaluation and revascularization can be performed at a CONUS facility days or weeks later.

LOWER EXTREMITY

Common Femoral Artery

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Interposition graft/ saphenous vein or 6-8mm prosthetic

Pearls

- Expose abdominal wall and artery coursing under inguinal ligament for proximal control.
- External iliac artery can be controlled through proximal groin or low abdominal incision.
- Coverage with tissue (femoral sheath), sartorius muscle or rectus flap.

Injury to the common femoral artery is often fatal as hemorrhage control in the field is difficult. Exposure is obtained through a single longitudinal incision above the artery (2-3 cm lateral to the pubic tubercle) exposing the artery at the inguinal ligament. A key point in exposing the femoral artery is placing the incision proximal enough so that the abdominal wall and inguinal ligament can be identified first in a consistent and familiar location. Alternatively, proximal control can be obtained in the retroperitoneum (i.e. external iliac) through the proximal extension of this groin incision or by using a limited transverse incision in the lower abdomen. After a transverse-oblique skin incision, the external and internal oblique aponeuroses are divided and the lateral fibers of the internal oblique separated. The transversus muscle and transversalis fascia are opened allowing entrance into the retroperitoneum, and the peritoneum is reflected cephalad, exposing the internal iliac vessels along the medial border of the psoas muscle. Common femoral artery injuries are most commonly reconstructed using reversed saphenous vein, although e-PTFE or Dacron can be used if there is too great of a size mismatch. Placement of a prosthetic graft is acceptable if there is minimal to no contamination and there is adequate coverage, at a Role 2 facility placing a shunt prior to transfer to a higher level of care is preferable to reconstruction with a prosthetic graft. Every attempt should be made to maintain flow into the profunda femoris artery, although the feasibility of this will depend upon the pattern of injury and the comfort level the surgeon to perform a more complicated reconstruction. Coverage of vascular reconstructions in the groin is challenging and the focus of Role 3-4 care and may consist of local viable tissue, the sartorius muscle or other options such as a rectus abdominis transfer flap. [2,17]

Profunda Femorus Artery

- Recommendations: Repair if possible
- Utility of temporary shunt: Low
- Method/ Conduit: Ligation or interposition graft/ saphenous vein

Pearls

- Exposure of proximal profunda is the same (distal extension) of the common femoral.
- If superficial femoral artery is injured, repair of profunda is necessary to heal amputations.
- If superficial femoral is patent, ligation of mid to distal profunda injury is acceptable.

Exposure of the proximal profunda femoris artery is obtained through a longitudinal incision used to expose the common femoral artery. Mid- and distal segments are exposed through a vertical incision made parallel to the

lateral border of the Sartorius muscle more lateral incision on the upper thigh, lateral to the proximal sartorius muscle. The sartorius is retracted medially and the rectus femoris is retracted laterally to expose the mid- and distal segments. Proximal profunda injuries should be repaired with reversed saphenous vein interposition graft. This is especially important if there is question about the integrity of the superficial femoral or popliteal vessels. In this setting flow through the profunda is most important to allow healing of subsequent lower extremity amputations. If patency of the superficial femoral artery can be confirmed, ligation of mid and distal profunda femoris injuries is acceptable as they lie deep in the thigh musculature and are not required for leg viability. [17]

Superficial Femoral Artery

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Interposition graft/ reversed saphenous vein

Pearls

- Medial incision with "bump" under calf, surgeon seated, OR lights over shoulder.
- Exposure of the proximal 1/3 posterior to the sartorius and distal 1/3 anterior to the Sartorius.
- Be wary of adjacent vein and geniculate branches of distal superficial femoral artery (Hunter's canal).

Exposure is performed through a medial thigh incision and the adductors of the leg (i.e. adductor magnus). Exposure is facilitated by placing a lift or "bump" below the knee which allows the femoral artery, sartorius and adductors to be suspended improving separation. Entry into the fascia of the lower thigh (distal superficial femoral artery) should be performed at the upper anterior margin of the sartorius which should be reflected down or posteriorly. Exposure is facilitated with the surgeon seated looking across to the dissection field with lights positioned directly over his or her shoulder if they do not have a headlight available.

When exposing the superficial femoral artery, it is important to recognize the femoral vein which is in close proximity, if not adherent, to the artery. At the distal extent of the artery as it exits the adductor (Hunter's) canal, there are large geniculate side branches which should be preserved or at least not injured which causes hemorrhage. Repair of superficial femoral artery injury is best performed by reversed saphenous vein interposition graft from the uninjured leg.[17]

Popliteal Artery

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Reversed saphenous vein

Pearls

- Medial incision with "bump" under calf for above knee and under thigh for below knee.
- Henley popliteal retractor with removable, varied depth side blades is valuable.
- Distal exposure by division of gastrocnemius and soleus from tibia allowing dissection to anterior tibial origin (coursing away from dissection plane) and tibial-peroneal trunk.

Vascular injuries in the popliteal space are exposed through a medial incision with the surgeon seated and lights over his or her shoulder. The dissection is extended from above to below the knee and is facilitated by a lift or "bump" under the calf of the leg with the knee flexed. When exposing below the knee, this bump is placed

under the thigh. Natural dissection planes exist in exposing the above knee popliteal artery (i.e. popliteal space) with the exception of the need to divide the fibers of the adductor magnus which envelop the distal superficial femoral artery (Hunter's canal). Similarly, a natural dissection plane exists into the popliteal space from below the knee, but added exposure should be accomplished by division of the gastrocnemius and soleus muscle fibers from the medial tibial condyle to allow a lengthy exposure of the below knee popliteal artery to the takeoff of the anterior tibial artery and the tibial-peroneal trunk. To completely expose the popliteal space, the medial attachments of the sartorius, semitendinosis, semimembrinosis and gracilis to the medial condyle of the tibia can be divided. When feasible, the pes anserinus should be reconstructed given its significant role in medial knee stabilization. Weitlaner, cerebellar retractors, flexible Adson- Beckman or Henly popliteal retractors with detachable side blades are necessary to expose the popliteal space. Typically the medial head of the gastrocnemius can be retracted down using one of these devices and does not need to be divided. [17]

Tibial Arteries

- Recommendations: Selective repair (i.e., some but not all)
- Utility of temporary shunt: Moderate
- Method/ Conduit: Ligation or interposition graft with saphenous vein

Pearls

- If a Doppler signal is present at the ankle, there is no need for additional tests or repair
- Doppler exam should be repeated as patient is resuscitated and warmed
- Repair with vein if three tibial arteries injured and an absence of a Doppler signal persists
- As long as there is at least one of the three tibial vessels intact, injuries to one or even two of the tibial vessels can safely be managed by ligation.

The recommended approach to tibial artery injury is one of selective repair (i.e. repair some but not all). Because of their distal location and redundant nature, isolated and sometimes multiple tibial artery injuries are able to be ligated without adverse outcomes. As long as one tibial artery is uninjured and patent to the ankle (i.e. an arterial signal at the ankle or foot), no additional tests or repair is required (especially at Roles 1-3). Continuous wave Doppler exam of the foot is critical in the setting of tibial artery injuries and concern for viability of the foot (i.e. patency of the remaining tibial vessel(s)). Doppler should be repeated over the first hours after injury, especially if the patient presents in shock or cold. Because of the capacity for vasoconstriction, what may initially appear as an ischemic foot from tibial vascular injury may improve with warming and resuscitation (i.e. return of arterial signal). If a signal does not return and there is concern for, or observation of, multiple tibial artery injuries, flow to the foot should be restored using a temporary shunt or interposition graft using saphenous vein.

This selective approach to tibial repair has been shown to be effective, confirming, that although tibial injuries can be ligated, there is a distinct injury pattern which requires repair. Temporary shunts may be placed in tibial vessels although success (patency) is lower than that in larger, more proximal vessels.

The anterior tibial artery is exposed through an anterolateral longitudinal incision midway between the tibia and fibula. The fascia along the lateral border of the anterior tibialis muscle is divided and the plane between the anterior tibialis and extensor digitorum longus muscles is developed. The anterior tibial artery lies along the interosseous membrane.

Exposure of the posterior tibial artery in the deep compartment of the leg is through a medial incision with a lift or "bump" under the knee or thigh. A longitudinal incision is made 2 cm posterior to the posterior margin of the tibia. Division of the tibial attachments of the soleus muscle in the proximal and mid-leg and posterior retraction of the soleus exposes the artery. Reconstruction of a peroneal artery injury is rarely required and ligation is

adequate. Importantly, tibial reconstruction is technically more challenging because of the smaller size of the vessels and may therefore take longer to complete. Like other vascular repairs, tibial reconstruction should not be undertaken if the patient has other life threatening injuries or is in extremis. [18]

Extremity Venous Injury

- Recommendations: Selective repair (i.e. some but not all)
- Utility of temporary shunt: Moderate
- Method/ Conduit: Ligation, repair or saphenous interposition graft

Pearls

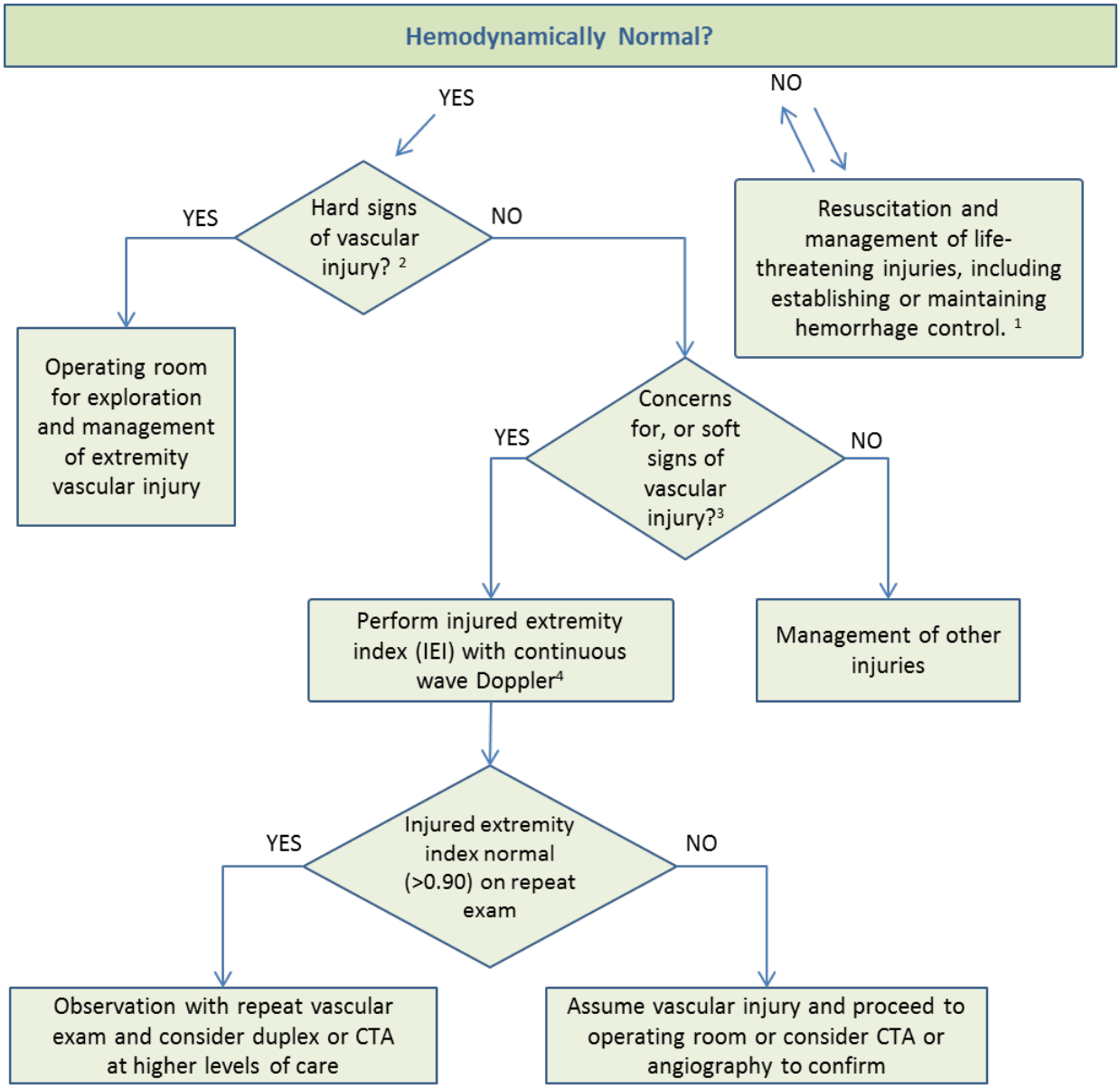
- Repair of proximal veins is indicated to reduce venous hypertension and congestion.
- Shunts in proximal veins will remain patent until formal repair can be performed.
- Pneumatic compression device on distal extremity to augment venous flow after repair.

Many extremity venous injuries, especially small, distal veins, can be ligated with no adverse effects because of collateral venous drainage. However, ligation of more proximal or watershed veins, or even axial veins when collaterals have been destroyed by soft tissue wounds, will result in venous hypertension and congestion. In such instances an attempt should be made to repair the vein and restore venous outflow. Temporary shunts have been shown to be effective in restoring venous outflow in the femoral veins until formal repair can be accomplished. Techniques of lateral venorrhaphy are acceptable, although an interposition graft using saphenous vein from the uninjured limb is often necessary.

The patency of vein repairs in the lower extremity is 80% at 24 months with no increased incidence of pulmonary emboli compared to ligation. Additionally, a limb salvage benefit of vein repair compared to ligation has been shown 2 years after injury.19,20 Despite these advantages, repair of extremity venous injury should only be considered in instances when the patient's overall status is able to tolerate additional operating; otherwise venous ligation is preferred, accepting the increase in morbidity.

Technical considerations include removing thrombus from the distal venous segments with compression (e.g. ace wrap or Esmark bandage) prior to repair. Additionally, following venous repair, placement of a pneumatic compression device distal on the extremity will augment venous flow and improve patency. Lastly, if there is no contraindication, a prophylactic dose of low-molecular weight heparin should be initiated. [19]

Figure 1. Algorithm for Extremity Vascular Injury


Hemodynamically Normal?
YES
NO
Hard signs of vascular injury? 2
YES
NO
Operating room for exploration and management of extremity vascular injury
Resuscitation and management of life-threatening injuries, including establishing or maintaining hemorrhage control. 1
Concerns for, or soft signs of vascular injury?3
YES
NO
Perform injured extremity index (IEI) with continuous wave Doppler4
Management of other injuries
Injured extremity index normal (>0.90) on repeat exam
YES
NO
Observation with repeat vascular exam and consider duplex or CTA at higher levels of care
Assume vascular injury and proceed to operating room or consider CTA or angiography to confirm

1. Do not release tourniquets or begin vascular injury exploration if patient is in shock from associated injuries
2. Hard signs: hemorrhage, expanding hematoma, absence of Doppler signal on repeated exam, audible bruit, palpable thrill
3. Soft signs: proximity to major vessel, fracture or dislocation patterns, diminished pulse, report of hemorrhage or shock
4. IEI is occlusion pressure of arterial Doppler signal on injured extremity divided by occlusion pressure of normal limb
   - Normal is > 0.90
   - Repeat Doppler exam and IEI during first hours after injury, especially if patient is cold and hypotensive

APPENDIX B: TORSO VASCULAR INJURY

Thoracic Aorta

- Recommendations: Selective repair
- Utility of temporary shunt: None, except in extremis
- Method/ Conduit: Observation and medical optimization or Dacron graft replacement

Pearls

- If a stable blunt injury, MEDEVAC to Role 3 for possible repair versus MEDEVAC to Role 4.
- Permissive hypotension or B-blocker may decrease risk of rupture
- If hemorrhage from penetrating wounds, entry through left 3rd or 4th interspace, one lung ventilation and rib removal to facilitate exposure of the proximal descending aorta

Management of penetrating injury to the thoracic aorta is very rare given the pre-hospital lethality of this injury. If present, management of thoracic hemorrhage in the setting of penetrating trauma is directed by chest tube location and output (i.e. the hemithorax which is bleeding from tube thoracostomy is the one which is opened). The descending thoracic aorta is approached through the left chest and when injured is surrounded by hematoma. An initial left thoracotomy can be extended into the right chest to approach the thoracic aorta by extending across the sternum ("clam shell" thoracotomy). Aortic control proximal and distal to the hematoma must be obtained including isolation or control of any intercostal arteries in this segment. Aortic clamps are used to arrest flow in this segment and the hematoma is entered with debridement of the injured aorta using scissors. An adequate length of aorta must be debrided to allow placement of large caliber (20-26mm) Dacron graft sewn end-to-end to the proximal and distal segments.

Management of blunt injury to the thoracic aorta (partial transection or pseudoaneurysm) which has reached a temporary stable equilibrium is more common. In this setting and in the absence of hemorrhage from chest tubes, contrast CT imaging is indicated to characterize the injury. Permissive hypotension and selective use of B-blockers is indicated to decrease the risk of aortic rupture during this period. If CT confirms blunt aortic injury, options include early open repair or MEDEVAC. In a patient at Role 1 or 2 with a suspected blunt aortic injury who has normal and stable vital signs and no signs of active hemorrhage from the thorax, MEDEVAC to the Role 3 should occur. At this location the decision will be made regarding options for open or endovascular repair or medical optimization and CCATT transport out of theater. Recent advances in in-theater endovascular capability have made endovascular repair of such injuries possible at certain Role 3 facilities.

Abdominal Aorta

- Recommendations: Repair
- Utility of temporary shunt: Low
- Method/ Conduit: Interposition graft / Dacron

Pearls

- Supraceliac aortic control requires high midline incision along xyphoid, spreading and suspension of rib cage with retractors and nasogastric tube in the esophagus.
- Approach supra-mesocolic Zone I hematomas with left medial visceral rotation (Mattox maneuver).
- Approach infra-mesocolic Zone I hematomas with right medial visceral rotation (Catell-Brash maneuver).

- Keep in mind that supra-mesocolic Zone I hematomas may contain transected pancreas.

Blunt and penetrating injuries to the abdominal aorta present as a central (zone I) hematoma with blood in the abdomen at laparotomy. Zone I hematomas should be considered in two locations, supra- or infra-mesocolic, and should be entered once proximal and distal control is established and blood and access are available for transfusion. Supra-mesocolic, Zone I hematomas are best approached by left medial visceral rotation (i.e. Mattox maneuver) which exposes the supraceliac, paravisceral and infrarenal segments of aorta. Infra-mesocolic Zone I hematomas should be approached with the Catell-Brash maneuver exposing the infrarenal aorta and inferior vena cava up to and behind the liver. Proximal aortic control is obtained through the gastrohepatic ligament by retracting the esophagus to the left and dividing the crus. Alternatively the Mattox maneuver exposes the supraceliac aorta from the lateral position, enabling proximal control as well. The iliac vessels or distal aorta can next be controlled, providing isolation before entering the hematoma. Repair techniques for the aorta and its branch vessels range from primary pledgetted closure to replacement with a Dacron interposition graft and depend upon the degree of injury.

Vena Cava

- Recommendations: Repair
- Utility of temporary shunt: Low
- Method/ Conduit: Lateral repair, patch angioplasty or interposition graft / ePTFE

Pearls

- Establish resuscitation lines above the diaphragm for abdominal vena cava injuries.
- Vena cava injuries should be exposed using the Catell-Brash and Kocher maneuvers.
- Lateral repair is acceptable provided that no more than 1/3rd of the lumen is compromised.
- If occlusion of the cava results in hypotension, clamp the aorta to support central perfusion.
- Retrohepatic, retroperitoneal hematomas should not be disturbed if not actively bleeding.
- Several specific strategies applicable to repair of the injured vena cava are listed in the Large Vein Injuries section (section VII).

The approach to the vena cava in the abdomen should be performed using the Cattell-Braasch and Kocher maneuvers exposing the cava, renal veins and the beginning portion of retrohepatic segment. Mobilization of the liver is required to expose the retro-hepatic vena cava; however retrohepatic hematomas should not be disturbed if there is no active bleeding.

Attempts should be made to identify large lumbar veins feeding into the injured segment which may bleed as much as the main channel of the vena cava if not controlled. Because repair of the vena cava is likely to require intermittent occlusion (i.e. sponge sticks or vascular clamps) or ligation in extreme cases, central venous access should be established above the diaphragm (i.e. subclavian or jugular veins) to allow effective volume resuscitation. If compressing or occluding the vena cava results in significant hypotension, the adjacent abdominal aorta may be temporarily occluded to support central pressures while resuscitation takes place. Repair of tangential injuries to the cava can be accomplished using lateral suture repair (i.e. running venorrhaphy) provided that the lumen is not narrowed more than ½ of its native diameter. If lateral repair results in significant narrowing, there is a higher risk of thrombosis leading to pulmonary emboli and anticoagulation should be initiated postoperatively if possible. In instances where lateral repair will result in more than 50% narrowing, patch angioplasty or resection and interposition graft using ePTFE is preferable. Ligation of the infrarenal cava is acceptable as a damage control maneuver, although this carries a significant mortality risk and major morbidity in the form of decreased cardiac preload and significant lower extremity edema. If infrarenal ligation is needed, it should always be accompanied by bilateral lower leg fasciotomies to

reduce the risk for compartment syndrome. Suprarenal occlusion of the IVC is generally not compatible with survival and should be considered a measure of last resort.24

Portal Vein and Hepatic Artery

- Recommendations: Repair
- Utility of temporary shunt: Low
- Method/ Conduit: Primary repair, patch angioplasty, interposition graft / ePTFE or Dacron or saphenous vein

Pearls

- Access to gastrohepatic ligament by Pringle maneuver should precede exploration of the porta hepatis.
- Ligation of hepatic artery injuries is acceptable if the portal vein is patent.
- Lateral venorrhaphy is preferred; ligation of portal vein results in massive bowel edema and systemic hypovolemia.
- Several specific strategies applicable to repair of the injured portal vein are listed in the Large Vein Injuries section (section VII).

Portal vein and hepatic artery injuries typically present as hematomas of the porta hepatis and should be explored after isolation of the gastrohepatic ligament and application of a Pringle maneuver. Next, careful dissection of the porta is performed to determine which structures have been injured. Injuries to the hepatic artery may be repaired with lateral suture placement if limited in severity; ligation of the hepatic artery is acceptable if the portal vein is uninjured. Repair of the portal vein should be attempted using the technique of lateral venorrhaphy if possible. If a large segment of the portal vein is damaged, vein patch angioplasty, or in rare instances, interposition vein graft may be performed. Ligation of the portal vein is an option of last resort and will result in hepatic ischemia and splanchnic congestion and hypervolemia for several days. Importantly, if the capabilities are available then imaging of the biliary system should be considered for associated injuries of the common bile duct and can be performed with cholangiography through the gall bladder.

Mesenteric Arteries

- Recommendations: Repair
- Utility of temporary shunt: Low
- Method/ Conduit: Primary repair, patch angioplasty, interposition graft / ePTFE or Dacron or saphenous vein

Pearls

- Present as supra-mesocolic Zone I hematoma.
- Repair proximal mesenteric artery and vein injuries including portal vein.
- Ligation can be performed for distal artery and vein injuries or as damage control.

Upon entering a supra-mesocolic Zone I hematoma, one may find injury to the mesenteric vessels (artery or vein). Under most circumstances, repair of the proximal superior mesenteric artery and vein, including the portal vein, is indicated using the techniques of primary pledgetted repair, vein patch angioplasty or replacement of the injured segment with interposition saphenous vein graft. The specific type of repair will depend on the location and extent of vessel injury. In cases where injury to the artery or vein is distal (i.e. beyond the middle colic artery or jejunal vein branches) or in which the patient's physiology is severely compromised, the vessels can be ligated.

Renal Arteries

- Recommendations: Selective repair
- Utility of temporary shunt: Low
- Method/ Conduit: Primary repair or patch angioplasty/Dacron or vein

Pearls

- Explore Zone II hematomas from penetrating injury.
- Establish status of contralateral kidney by contrast study or manual palpation.
- Priority is "save-life," and early nephrectomy is required with complex injuries.
- With a renal warm ischemic time > 30-60 minutes, complex repairs are not indicated.

Injury to the renal pedicle (blunt or penetrating) is closely associated with injury to the parenchyma; isolated arterial injury is rare. Essential considerations in the management of renal artery injury in wartime are the warm ischemic time of 30-60 minutes and complexity of renal artery repair. Both of these limit what the surgeon can accomplish in the context of renal artery injury other than ligation and nephrectomy.

If arterial injury manifests as occlusion with renal ischemia, it will be too late to restore flow and function to the kidney by the time the diagnosis is made in the operating room or CT scanner. If the artery is patent and bleeding, an associated Zone II or lateral hematoma requiring exploration will be present and attempts to stop hemorrhage and repair are indicated. These maneuvers may include pledgetted primary repair of the renal artery, patch angioplasty or very rarely interposition graft replacement (aorto-renal bypass). Again, considering the warm ischemic time of the kidney, complex operations to maintain or reestablish perfusion in the renal artery are not recommended and should be abandoned in favor of nephrectomy in most cases.

The method by which to approach an expanding or penetrating zone II hematoma is controversial and case specific. Isolation of the renal pedicle before exploring the hematoma is doctrine in many institutions and has the advantage of aortic isolation and definitive proximal control. However from a practical standpoint, mobilization of the damaged kidney from a lateral to medial direction without hilar control may be faster depending upon the appearance of the injury. The lateral to medial approach is similar to the medial visceral rotation performed for zone I injuries.

Iliac Arteries

- Recommendations: Repair
- Utility of temporary shunt: High
- Method/ Conduit: Interposition graft/ ePTFE or Dacron or saphenous

Pearls

- Explore Zone III hematoma from penetrating wound after establishing aortic control above the hematoma.
- Distal control is obtained at the inguinal ligament (i.e. external iliac arteries).
- Wylie hypogastric (internal iliac) clamps facilitate low-profile control of iliac arteries.

Iliac artery injuries generally present as a Zone III or pelvic hematoma with or without extremity ischemia (check femoral pulses). Exploration of the hematoma should be performed after proximal control is obtained at the infrarenal aorta and the contralateral iliac artery if possible. The distal external iliac artery should be found as it exits the pelvis at the inguinal ligament at a point where it is free from the hematoma. The internal iliac artery

may not be initially controlled or visualized before exploring the hematoma, which often requires opening to expose the internal iliac. The inability to initially control all bleeding from the hematoma necessitates preparation including multiple suction devices, Fogarty occlusion balloons (if available) direct tamponade strategies or devices and alerting anesthesia regarding the need for continued resuscitation during exploration. After proximal and distal control of the common and external iliac arteries is obtained, the hematoma is entered which facilitates exposure and clamping of the internal iliac artery and the injured vessel(s). Common and external artery injuries can be controlled and managed with a temporary vascular shunt if needed or repaired with interposition grafting using saphenous vein or prosthetic conduit (6-8mm ePTFE or Dacron). In an unstable patient or a patient where there is contamination of the field, shunt placement with definitive repair or reconstruction done at a later point is a good option.

If the primary injury is to the internal iliac artery (hypogastric), it may be ligated with 3.0 or 4.0 Prolene on an SH needle. Bleeding from associated iliac veins may be severe and difficult to expose. The iliac artery may be divided if necessary to facilitate exposure of the iliac vein, followed by repair of the artery. At certain Role 3 facilities with endovascular capabilities, selective embolization of bleeding hypogastric artery or branches is an option, particularly in blunt trauma (e.g., pelvic fracture.) The principles which apply to the management of iliac vein injury are discussed in the Management of large vein injuries section.

APPENDIX C: CERVICAL VASCULAR INJURY

Carotid Artery

- Recommendations: Repair.
- Utility of temporary shunt: High.
- Method/ Conduit: Vein patch or vein interposition graft.

Pearls

- Zone I cervical injuries best approached with median sternotomy for ample proximal exposure.
- Early control of common carotid with umbilical tape/Rummel or DeBakey clamp.
- 3 Fr Fogarty with 3-way stopcock is useful to occlude internal carotid back bleeding.
- Shunt and augment mean arterial pressure during carotid repair to perfuse brain.

Most carotid injuries result from penetrating wounds and result in hematoma. Indications for operation are bleeding or injury with interrupted flow (i.e. occlusion). When feasible, contrast CT should be performed for neck wounds. CT aids in the triage for urgent operation, improves operative planning and images the brain as a baseline. Although a selective approach to exploration of zone II neck wounds is acceptable, if a carotid injury is identified, the neck should be explored and an attempt made to repair. The exceptions are blunt injury resulting in carotid occlusion greater than 12 hours or a zone III injury not accessible by standard techniques.

Exposure of the carotid artery is through a generous incision coursing anterior to the sternocleidomastoid and facilitated by a roll under the shoulders, extension of the neck and turning of the head away from the injury. The platysma is divided and the sternocleidomastoid muscle reflected posterolaterally. The internal jugular vein is carefully dissected and mobilized laterally, exposing the carotid artery. The carotid is exposed proximal to the hematoma and controlled with an umbilical tape into a Rummel device (i.e. red rubber catheter). In the absence of uncontrolled bleeding, there is no need to tighten the Rummel; but having it in place gives one this option and allows for securing the proximal end of a temporary shunt.

The dissection proceeds distal into the zone of injury. If bleeding is encountered the Rummel may be cinched or a clamp (angled DeBakey) slid proximal to the umbilical tape using it to pull the carotid up into the clamp, thereby avoiding injury to the vagus nerve. Back bleeding from the internal carotid artery is a favorable sign and can be controlled with a small clamp or a (3 Fr) Fogarty inserted into the internal and inflated using a 1cc syringe and 3-way stop-cock to maintain inflation. The external carotid artery is controlled with vessel loops or ligated. If the internal and common carotid arteries are controlled above and below the injury, a temporary shunt can be placed to maintain perfusion while the injury is identified and options considered. First, the shunt should be placed into the internal carotid artery and secured with a vessel loop or small Javid shunt clamp allowing back bleeding through the shunt. To secure the proximal shunt, an angled DeBakey is placed proximal to the umbilical tape and Rummel device. Then in sequence, the shunt is placed in the common carotid through the Rummel which is partially tightened around the shunt. As it is advanced deeper (more proximal) into the common carotid, the DeBakey clamp is slowly opened allowing the shunt to pass while the Rummel is tightened down fully securing the shunt in place. Alternatively the common carotid artery can be controlled with fingers as the shunt is inserted proximal and the Rummel synched down. If available, Javid shunt clamps can be used to occlude the artery around the shunt instead of the Rummel device.

Repair of carotid artery injuries most commonly requires placement of an interposition saphenous vein graft, although primary repair or vein patch angioplasty can be performed for less severe injuries. To perform the interposition graft over the shunt, the proximal end is removed using the DeBakey clamp to again occlude the common carotid proximal to the Rummel. The vein graft is next placed over the shunt (i.e. shunt in the vein graft lumen). The proximal shunt is reinserted into the common carotid and secured with the Rummel using

previously described sequence. After flow is restored in the shunt, the distal vein graft anastomosis is performed using 6-0 Prolene to the edge of the normal internal carotid. Next the proximal anastomosis to the common is started also with 6-0 Prolene. When the anastomosis is nearly completed, the shunt is removed through the remaining anastomotic opening, first removing the proximal from the common carotid and observing back bleeding from the shunt in the internal carotid. Finally the shunt is removed from the internal and the vein graft flushed generously with heparinized saline and the anastomosis completed. Alternatively the reconstruction can be performed without a shunt, however, this exposes the ipsilateral hemisphere to prolonged ischemia. Regardless of whether or not a shunt is used, the mean arterial pressure should be kept above 90mmHg during the repair to optimize cerebral perfusion.

Alternatively the reconstruction can be performed without a shunt, however, this exposes the ipsilateral hemisphere to prolonged ischemia. Regardless of whether or not a shunt is used, the mean arterial pressure should be kept above 90mmHg during the repair to optimize cerebral perfusion. If no other life threatening injuries are present, a small amount (50u/kg) of systemic heparin is recommended along with generous flushing of the repair with heparinized saline to prevent platelet aggregation and clot formation. Ligation of the internal carotid artery is an acceptable damage control maneuver to stop hemorrhage but has an acute stroke rate of 30-50%.

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Vertebral Artery

- Recommendations: Ligate
- Utility of temporary shunt: None
- Method/ Conduit: N/A

Pearls

- Bleeding vertebral artery injuries are ligated with no role for reconstruction in theater.
- Vertebral artery occlusions are managed with anticoagulation if it is not contraindicated.
- Endovascular embolization is an option if injury is not accessible by standard exposure.

Repair of vertebral artery injuries in wartime is extremely rare and most commonly bleeding from this vessel is ligated as a matter of necessity during neck exploration. Alternatively, vertebral artery injury (occlusion or extravasation) can be discovered on a contrast CT scan. There should be a high index of suspicion for this injury with cervical spine fractures. In instances of acute vertebral artery occlusion, anticoagulation is recommended to reduce the risk of posterior circulation stroke although the clinical evidence to support this is limited. If associated injuries preclude use of systemic heparin, then antiplatelet therapy should be initiated.

Jugular Vein

- Recommendations: Selective repair
- Utility of temporary shunt: None
- Method/ Conduit: Lateral venorrhaphy, vein patch or saphenous vein

Pearls

- Significant jugular vein injuries can be ligated without adverse effects.
- Repair of jugular injuries should be considered in the setting of TBI with elevated ICP.

Repair instead of ligation of jugular vein injuries may be indicated in instances of associate closed head injury to reduce intracranial pressures, although little data exists to support this practice. Minor jugular vein injuries can be repaired by lateral suture repair (venorrhaphy) while patch angioplasty or interposition vein graft are options for more extensive injuries. Operative exposure of the jugular vein is the same as that described for the carotid artery.

APPENDIX D: MISCELLANEOUS TOPICS

LARGE VEIN INJURIES

Pearls

1. **Formal control (DeBakey clamps) is acceptable** but may be difficult or not advisable as it risks causing injury or may not be needed if injury is limited to the side wall of the vein.
2. **Initial control** can be accomplished by one or more fingers on the bleeding segment.
3. **Organize the operating room and confirm availability of blood and central venous access.**
4. **Venous access** above the heart if operating on injury to the inferior vena cava.
5. **Optimal lighting**, exposure (i.e. extend incisions) and two or more suction devices.
6. **Avoid too small of a needle and suture** which are difficult to maneuver in blood. 4-0 Prolene on an SH tapered needle is substantive suture on a needle large enough to see.
7. **Fingers replaced with a low profile tampanode device** such as a small sponge stick or Wecksorb "K" dissector (i.e. Kitner device) as bleeding is evacuated.
8. **Passes of suture are made** capturing muscle or soft tissue if possible (i.e. pledget-effect). Tie the knot to begin running venorrhaphy or place second pass in "figure-of-8" fashion.
9. **Felt pledgets can be used,** but may not be available.
10. **Hemorrhage control with ligation** is preferable to patency with death from exsanguination.

LIGATION OF VESSELS

Pearls

1. **Acceptable damage control maneuver** especially for small, more distal arteries and veins
2. **Temporary vascular shunting** to restore perfusion should be considered before ligation
3. **Continuous wave Doppler** should be checked before ligation to judge perfusion/viability

Ligation of vascular injuries was the mainstay of treatment for centuries and should not be overlooked as a damage control option; especially at Role 2 facilities where operations are best abbreviated (≤ 1 hr). This technique is especially useful in small distal vessels (tibial, forearm and arm below the take-off of the profunda brachial artery) when patients are in extremis. Use of temporary vascular shunts or even repair should be considered before ligation, however, if not available or feasible ligation should be completed. Continuous wave Doppler may also be useful in assessing perfusion to the extremity distal to the vessel in question.

FOGARTY THROMBECTOMY CATHETERS

Pearls

1. Sized at 2-7 Fr; **maximum balloon diameter** of the 2 and 3 Fr catheters is 4 and 5 mm.
2. **Inflate with saline** using 1cc tuberculin syringe (0.2-0.75cc) while withdrawing from vessel.
3. **Goal is clot, not intima,** removal so don't over-inflate or "drag" too much.
4. **May be used to control bleeding** with use of a 3-way stop cock to maintain inflation.

Fogarty catheters are a key tool in the armamentarium of vascular injury management. Used primarily to remove thrombus, they can also be used to arrest bleeding from within the lumen of the vessel. The most common size used in extremity vascular injury is 2 and 3 Fr although the maximum inflated diameter of the 4 Fr Fogarty catheter is 9 mm which can be used for balloon occlusion of the femoral and iliac vessels. At least one pass of a Fogarty should precede extremity vascular injury repair to assure removal of the traumatic thrombus burden before restoring inflow and outflow. The key tenet is not to cause native vessel damage. To lessen the risk of damage, avoid advancing the catheter too distal in the smaller vessels of the leg and arm and avoid over aggressive, static balloon inflation (i.e. angioplasty or "intimectomy"). Using a Fogarty balloon to control bleeding from within the vessel lumen requires a 3-way stop cock to maintain inflation once the bleeding has been stopped.

TEMPORARY VASCULAR SHUNTS

Pearls

1. Inline shunts rest in the vessel ("in-situ") while long external shunts are designed to loop.
2. In-line Argyl shunts come in cylinder container with 8, 10, 12 and 14 Fr sizes.
3. In-line Javid shunts are longer and individually packaged.
4. Sundt shunts are designed with short (15cm; inline) and long (30cm; external) profiles.
5. Equal success has been had with Argyl, Javid and Sundt without systemic anticoagulation.
6. Secured with silk ligatures, patent for up to 6 hours; reports of longer duration exist.
7. Shunts should be removed with formal repair in-theater prior to medevac to Role 4.

Temporary vascular shunts are effective and should be considered in the management of nearly all extremity vascular injury patterns including proximal venous injuries. Their main advantage is provision of early restoration of flow and mitigation of the damaging effects of arterial ischemia and venous hypertension. As an abbreviated procedure compared to formal vascular repair, shunting extends the window of opportunity for limb salvage in some patterns of vascular injury. Although the patency at 3-4 hours is higher in larger, more proximal vessels (axillary/brachial and femoral/popliteal), shunts have been used effectively in smaller (distal brachial/forearm and tibial) vessels. Outcomes of extremity vascular injury managed with temporary shunts have been recorded demonstrating no adverse effect of this technique and a limb salvage advantage in the most severely injured limbs (MESS ≥ 8). [2, 5, 20]

PEDIATRIC VASCULAR INJURIES

Pearls

1. Intervention should be avoided in those less than 10 years old given propensity for spasm.
2. Ligation is more well tolerated in infants and toddlers given ability to recruit collaterals.
3. Perform interrupted suture lines (6-0 Prolene) to allow expansion with growth of child.

Although rare, deployed surgeons can expect to see young patients with vascular injury. Intervention of any type, including angiography, should be avoided in those less than 5 years even if an extremity appears ischemic (i.e. without Doppler signal). The small size of arteries in children and their propensity for vasospasm makes it more likely that an intervention will do harm or confuse the clinical scenario rather than improve the situation. Because of the ability of children to tolerate relative limb ischemia and to develop collateral circulation, ligation of bleeding vessels alone is recommended with warming of the extremity and resuscitation. In rare cases, in children older than 8, reconstruction of larger proximal arteries can be accomplished using reversed saphenous

vein. In such instances, the anastomosis should be performed using interrupted suture allowing expansion as the child grows. 16

ENDOVASCULAR CAPABILITY & INFERIOR VENA CAVA FILTERS

(See Trauma-Specific Endovascular Inventory Tables) [14]

Pearls

1. Techniques should be used in a small subset of injuries and directed by a trauma surgeon.
2. Indications for vena cava filter include inability to initiate chemoprophylaxis within 48 hours of injury and the occurrence of pulmonary embolus while on chemoprophylaxis.

The emergence of catheter based, endovascular technology to manage injury in the civilian setting has been expanded to the wartime setting. Although advantageous in a small set of combat injuries, endovascular capability in austere settings is in its early stages and its application should be directed by appropriately trained surgeons or interventional radiologists. Injury patterns and procedures which lend themselves to endovascular techniques include central injuries of the thoracic aorta and brachiocephalic vessels (subclavian and carotid) and select patterns of solid organ and pelvic injury amenable to coil embolization. Placement of vena cava filters to reduce the risk of pulmonary thromboembolic events is indicated in patients who cannot receive chemoprophylaxis or therapy with heparin. A trauma specific endovascular inventory for in-theater capability is listed in Trauma-Specific Endovascular Inventory Tables.

Indications for placement of an inferior vena cava filter include an inability to initiate chemoprophylaxis with low molecular weight heparin within 48 hours of a significant injury and the occurrence of a pulmonary embolus while on chemoprophylaxis. Examples of contraindications to chemoprophylaxis include significant traumatic brain, solid organ or pelvic injuries with bleeding. The Günther-Tulip™ (Cook Medical, Inc.) filter is currently recommended because of its established record of success and it ability to be removed in certain circumstances. (See Trauma-Specific Endovascular Inventory Tables.)

USE OF PROSTHETIC GRAFT MATERIAL

Pearls

1. **ePTFE (Gortex) or Dacron** used for central torso vascular injuries (aorta, great vessels).
2. **Prosthetic conduit acceptable as last resort** in extremities when vein cannot be harvested.
3. **If prosthetic used in extremity injury, notify higher levels of care to facilitate surveillance.**

Prosthetic graft materials such as ePTFE (Gortex) or Dacron should be reserved for open reconstruction of the aorta and large torso vessels and used very rarely as conduit for extremity vascular injury. Wartime experience has demonstrated poor incorporation of prosthetic grafts in extremity wounds and a propensity for infection compared to saphenous vein. Additionally, extrapolation of civilian data suggests improved patency of vascular reconstructions using saphenous vein. In the rare instance (i.e. damage control) when prosthetic conduit is used for extremity vascular injury, communication with higher levels of care should occur so that appropriate surveillance or even removal of the graft and replacement with vein can occur. [2]

HARVESTING & USE OF AUTOLOGOUS VEIN

Pearls

1. Use reversed greater saphenous vein from uninjured extremity.
2. Expose at saphenofemoral junction or anterior to medial maleolus (consistent locations).
3. Be sure to mark anatomically distal end as "in-flow" assuring reversal of vein conduit.
4. Introduce 18 ga. plastic vein or metallic olive tip cannula to distend with heparin saline.

Because of its versatility, resistance to infection, propensity for tissue incorporation and favorable patency rates, saphenous vein for interposition graft or patch material is favored. The greater saphenous vein s may be consistently located at the saphenofemoral junction (2cm medial to the pubic tubercle) or 1-2 cm anterior to the medial malleolus. Identifying the actual saphenofemoral junction is important to confirm that the vein being exposed is truly the main channel saphenous and not an accessory branch or anterior saphenous (i.e. must follow back to main saphenofemoral junction). Nearly always in the setting of trauma the vein appears in-situ as "too small" or "not adequate" due to vasoconstriction or spasm.

Nonetheless, after confirming that the vein being exposed is the main channel saphenous, the specimen should be removed and dilated on the back table with firm infusion of heparin saline using a 14-18 gauge plastic vein cannula or the metallic olive tip cannula. Persistence and this maneuver almost always results in a markedly improved and dilated vein ready to be used for repair. Reversal of the vein must also be confirmed as venous valves will not permit flow in a retrograde fashion.

SOFT TISSUE COVERAGE & ANASTAMOTIC DISRUPTION

Pearls

1. **Cover vascular repairs** with available, viable local tissue (muscle and adipose)
2. If no soft tissue to cover, **route grafts** out of zone of injury.
3. A poorly covered **vascular anastamosis** can "blowout," but not in the early (< 5 day) period.
4. **Avoid direct placement of negative pressure** wound therapy sponge on vascular structures.

Soft tissue coverage of vascular repairs is required to assure incorporation and prevent infection and blowout. Option 1 is to immediately cover the repair with viable local soft tissue (muscle and adipose). The negative pressure wound therapy device (VAC®, Kinetic Concepts Inc.) is useful on top of such coverage as it provides a closed dressing which removes wound effluent and decreases bacterial counts. This wound adjunct has been found to assist with accomplishing delayed primary closure of soft tissue wounds over vascular repairs or coverage with skin grafts. The reticulated open-cell foam sponge of the VAC® should not be placed directly on vessels, however when used over viable tissue covering the vascular repair, VAC® has resulted in excellent outcomes with no increase in graft-related complications or blowouts.

If no tissue is available to cover the vascular repair, one can route an interposition graft out of the zone of injury through another myocutaneous or even subcutaneous path. As a last resort, the vascular reconstruction can be left with marginal coverage at Role 2 and 3 facilities; however in these cases close examination must occur at Role 4 facilities. In these rare instances higher levels of care should pursue transfer of viable tissue from other locations (sartorius, rectus abdominis or other muscle) in order to definitively cover the repair within 5-7 days. Although it is acceptable for Role 2 and 3 providers to leave a graft with uncertain coverage, the onus of care then falls heavily on Role 4 facilities to inspect, cover, re-route or even ligate the graft to reduce the risk of catastrophic blowout.

It is important to recognize that even in the best of civilian and wartime circumstances that there has been historically and remains currently a finite risk of anastomotic disruption. Using the management strategies described above the risk of graft blowout has been within an acceptably low range of 1-2% throughout the wars in Iraq and Afghanistan. [15, 23]

ANTICOAGULATION/RECOMBINANT FACTOR VII USE

Pearls

1. **Heparin saline is typically 1000u/liter** although other mixtures with or without papaverine are acceptable; there is no evidence that other 'vein solutions' offer any advantage.
2. **Systemic anticoagulation** is achieved with 50 u/kg of IV heparin with1000 u repeated at 1 hr; repeat doses are not recommended given the propensity for bleeding in wartime injury.
3. **"Regional anticoagulation"** is the use of heparin saline flush in the inflow/outflow vessels.
4. The **use of recombinant factor VII** is no longer recommended

TRAUMA-SPECIFIC ENDOVASCULAR INVENTORY TABLES

Table 1. Imaging Systems, Endovascular Accessories, Wires and Sheaths

Imaging systems and hardware	
Description	**Quantity**
General Electric Mobile Fluoroscopic Unit with Vascular Imaging Package (9800 or Greater) **Or** Philips BV Pulsera with Vascular Imaging Package Mobile Fluoroscopy Unit	2 (at Role 3, 2 working fluoroscopy units with vasc package + 1 in storage- this has proven itself)
Medrad Mobile Power Contrast Injection System (not CT Scan Component) Mark V ProVis PPD 110 60 507 with Initial Disposables	1
Zonare Z.ONE Mobile Ultrasound Machine with Peripheral Vascular Imaging Package	1
Mobile Fluoro Table: Steris Surgigraphic 6000 Volts: 100/120/220/230-240 Amps: 5.0/4.2/2.4/2.0 Hz 50/60	1

Accessories			
Company	**Catalog #**	**Description**	**Quantity**
Boston Scientific	44-169	Arterial Entry Needle/18 gauge (box 10)	20
Navilyst	45-994	Mini-Stick/5 Fr/Nitinol w/Plat tip Wire (micro-puncture kit)	20
Boston Scientific	15-105	Inflation Device (Each)	5
Boston Scientific	46-550	Torque Device (box 12)	25
Boston Scientific	15-322	Gateway Y-Adapter (box 10)	20
Navilyst	90510002	Off-line Waste Container+/500 mL capacity	40
Navilyst	70055009	Namic 3-way Stopcock+/Rotating Adaptor, Port on Right/1050 psi	50
Navilyst	91051483	Female to rotating adapter 48” flexCI (1200PSI) high pressure injection tubing	25

Wires			
Company	**Catalog #**	**Description**	**Quantity**
Boston Scientific	46-502	Amplatz Super Stiff™ Wire/.035/260cm/J-tip (box 5)	10
Boston Scientific	46-525	Amplatz Super Stiff™ Wire/.035cm/180 (box 5)	10
Boston Scientific	46-526	Amplatz Super Stiff™ Wire/.035cm/260cm (box 5)	10
Boston Scientific	46-152	Zipwire™/.035/180cm/angled tip (box 5)	10
Boston Scientific	46-154	Zipwire™/.035/260cm/angled tip (box 5)	10
Boston Scientific	49-147	Standard starter wire with Bentson or J-tip/.035/180cm (box 5)	10
Boston Scientific	49-157	Standard Rosen starter wire /.035/260cm (box 5)	10

Sheaths			
Company	**Catalog #**	**Description**	**Quantity**
Starter and Short Sheaths			
Boston Scientific	15-711B	Super Sheath™/5 Fr/11cm	10
Boston Scientific	15-962B	Super Sheath™ RO/6 Fr /11cm	10
Boston Scientific	15-963B	Super Sheath™ RO/7 Fr /11cm	10
Boston Scientific	15-964B	Super Sheath™ RO/8 Fr /11cm	10
Boston Scientific	15-966B	Super SheathC RO/7 Fr /25cm (box 10)	10
Boston Scientific	15-967B	Super Sheath™ RO/8 Fr /25cm (box 10)	10
Boston Scientific	15-969B	Super Sheath™ RO/9 Fr /11cm (box 10)	10
Boston Scientific	15-727B	Super Sheath™ /11 Fr /11cm (box 10)	10
Boston Scientific	15-740B	Super Sheath TM/14 Fr/11 cm (box 10)	10
Boston Scientific	15-739B	Super Sheath TM/14 Fr/25 cm (box 10)	10
Long, Small Diameter Sheaths			
Terumo	RSR01	Destination® Sheath/6 Fr/45cm	5
Terumo	RSC05	Destination® Sheath/6 Fr /90cm	5
Long, Large Diameter Sheaths			
Arrow International	CL-07980	Super ArrowFlex™/9 Fr /80 cm	4
Arrow International	CL-71180	Super ArrowFlex™/11 Fr /80 cm	4
Cook, Inc	G09691	Check-Flo™ G09691 RCFW-16.0P-38-30-RB/16Fr/30cm	4

Table 2. Catheters and Balloons

Catheters			
Company	**Catalog #**	**Description**	**Quantity**
Boston Scientific	31-531	Imager™ II/Contralateral Flush/5/65cm	10
Boston Scientific	31-515	Imager™ II/Pigtail Flush/5Fr/100cm	10
Boston Scientific	31-410	Imager™ II/BERN/5Fr/65cm	10
Boston Scientific	31-405	Imager™ II/BERN/5Fr/100cm	10
Boston Scientific	31-414	Imager™ II/H1/5Fr/100cm	10
Boston Scientific	31-458	Imager TMII/Contra 2/5Fr/65cm	10
Cook Medical	G11209	Beacon Tip Visceral Selective HNBR5.0-38-80-P-NS-VS	10
Terumo Medical	CG505	Glidecath®/5/ST/65cm±	15
Terumo Medical	CG506	Glidecath®/5/ST/100cm±	15
AngioDynamics	12401812	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx10cm infusion lengthΔ	2
AngioDynamics	12401813	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx20cm infusion lengthΔ	2
AngioDynamics	12401815	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx40cm lengthΔ	2

Angioplasty and Compliant Occlusion Balloons			
Company	**Catalog #**	**Description**	**Quantity**
Medtronic, Inc.	REL46	Reliant™ Large diameter (46mm) occlusion balloon* (100cm length, 12 Fr sheath)	2
Boston Scientific	17-566	UltraThin™ SDS/4-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-568	UltraThin™ SDS/4-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-596	UltraThin™ SDS/5-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-598	UltraThin™ SDS/5-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-626	UltraThin™ SDS/6-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-628	UltraThin™ SDS/6-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-656	UltraThin™ SDS/7-40mm/75 cm length delivery+ (6Fr sheath)	2
Boston Scientific	17-658	UltraThin™ SDS/7-40mm/135 cm length delivery+ (6Frsheath)	2
Boston Scientific	17-686	UltraThin™ SDS/8-40mm/75 cm length delivery+ (6Fr sheath)	2
Boston Scientific	17-688	UltraThin™ SDS/8-40mm/135 cm length delivery+ (6Frsheath)	2
Boston Scientific	17-711	UltraThin™ SDS/9-40mm/75 cm length delivery+ (7Fr sheath)	2
Boston Scientific	17-713	UltraThin™ SDS/9-40mm/135 cm length delivery+ (7Frsheath)	2
Boston Scientific	17-736	UltraThin™ SDS/10-40mm/75 cm length delivery+ (7Frsheath)	2
Boston Scientific	17-738	UltraThin™ SDS/10-40mm/75 cm length delivery+ (7Frsheath)	2
Catheters			
Company	**Catalog #**	**Description**	**Quantity**
Boston Scientific	31-531	Imager™ II/Contralateral Flush/5/65cm	10
Boston Scientific	31-515	Imager™ II/Pigtail Flush/5Fr/100cm	10
Boston Scientific	31-410	Imager™ II/BERN/5Fr/65cm	10
Boston Scientific	31-405	Imager™ II/BERN/5Fr/100cm	10
Boston Scientific	31-414	Imager™ II/H1/5Fr/100cm	10
Boston Scientific	31-458	Imager TMII/Contra 2/5Fr/65cm	10
Cook Medical	G11209	Beacon Tip Visceral Selective HNBR5.0-38-80-P-NS-VS	10
Terumo Medical	CG505	Glidecath®/5/ST/65cm±	15
Terumo Medical	CG506	Glidecath®/5/ST/100cm±	15
AngioDynamics	12401812	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx10cm infusion lengthΔ	2
AngioDynamics	12401813	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx20cm infusion lengthΔ	2
AngioDynamics	12401815	Uni*fuse™ Infusion/Thrombolytic Catheter/5Fr x135cmx40cm lengthΔ	2

Angioplasty and Compliant Occlusion Balloons			
Company	**Catalog #**	**Description**	**Quantity**
Medtronic, Inc.	REL46	Reliant™ Large diameter (46mm) occlusion balloon* (100cm length, 12 Fr sheath)	2
Boston Scientific	17-566	UltraThin™ SDS/4-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-568	UltraThin™ SDS/4-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-596	UltraThin™ SDS/5-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-598	UltraThin™ SDS/5-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-626	UltraThin™ SDS/6-40mm/75 cm length delivery+ (5Fr sheath)	2
Boston Scientific	17-628	UltraThin™ SDS/6-40mm/135 cm length delivery+ (5Frsheath)	2
Boston Scientific	17-656	UltraThin™ SDS/7-40mm/75 cm length delivery+ (6Fr sheath)	2
Boston Scientific	17-658	UltraThin™ SDS/7-40mm/135 cm length delivery+ (6Frsheath)	2
Boston Scientific	17-686	UltraThin™ SDS/8-40mm/75 cm length delivery+ (6Fr sheath)	2
Boston Scientific	17-688	UltraThin™ SDS/8-40mm/135 cm length delivery+ (6Frsheath)	2
Boston Scientific	17-711	UltraThin™ SDS/9-40mm/75 cm length delivery+ (7Fr sheath)	2
Boston Scientific	17-713	UltraThin™ SDS/9-40mm/135 cm length delivery+ (7Frsheath)	2
Boston Scientific	17-736	UltraThin™ SDS/10-40mm/75 cm length delivery+ (7Frsheath)	2
Boston Scientific	17-738	UltraThin™ SDS/10-40mm/75 cm length delivery+ (7Frsheath)	2

Table 3. Endovascular Stents

Bare Metal, self-expanding				
Company	**Catalog #**	**Description**		**Quantity**
Boston Scientific	38948-6401	Sentinol™ 6x40mmx135 cm length delivery+ (6Fr sheath)		2
Boston Scientific	38948-7401	Sentinol™ 7x40mmx135 cm length delivery+ (6Fr sheath)		2
Boston Scientific	38948-8401	Sentinol™ 8x40mmx135 cm length delivery+ (6Fr sheath)		2
Boston Scientific	38948-1401	Sentinol™ 10x40mmx135 cm length delivery+ (6Fr sheath)		2
Covered, self-expanding endografts and aortic/large vessel endografts				
Company	**Catalog #**	**Description**		**Quantity**
W.L. Gore	VBC050502	Viabahn™ 5x50mmx120 cm length delivery (7Fr sheath)		4
W.L. Gore	VBC060502	Viabahn™ 6x50mmx120 cm length delivery (7 Fr sheath)		4
W.L. Gore	VBC080502	Viabahn™ 8x50mmx120 cm length delivery (8 Fr sheath)		4
W.L. Gore	VBC100502	Viabahn™ 10x50mmx110 cm length delivery (11 Fr sheath)		4
Company	**Catalog #**	**Item#**	**Description**	**Quantity**
Medtronic	TB2222C116X	M708499B001	TALENT Thoracic 22mm	1
Medtronic	TF2424C116X	M708499B001	TALENT Thoracic 24mm	1
Medtronic	TF2828C116X	M708499B001	TALENT Thoracic 28 mm	1
Company	**Catalog #**	**Description**		**Quantity**
Medtronic	IEXC121255	AneuRx AAAdvantage Iliac Limb Ext 12mm		2
Medtronic	IEXC141455	AneuRx AAAdvantage Iliac Limb Ext 14mm		2
Medtronic	IEXC161655	AneuRx AAAdvantage Iliac Limb Ext 16mm		2
Medtronic	IEXC181855	AneuRx AAAdvantage Iliac Limb Ext 18mm		2
Medtronic	AEXC202040	AneuRx AAAdvantage Aortic Cuff Extension 20mm		2
Medtronic	AEXC242440	AneuRx AAAdvantage Aortic Cuff Extension 24mm		2
Medtronic	AEXC282840	AneuRx AAAdvantage Aortic Cuff Extension 26 mm		2

Table 4. IVC Filters and Ancillaries

IVC Filters, retrievable			
Catalog #	**Description**		**Quantity**
Cook, Inc	IGTCFS-65-JUG	Gunther-Tulip/Jugular	5
Cook, Inc	IGTCFS-65-FEM	Gunther-Tulip/Femoral	5
Embolics, Snares, Dilators, Thrombolytics, and Low Osmolarity Contrast			
Coils, Cook Medical			
Catalog #	**Description**		**Quantity**
G10415	Tornado Platinum Coils/.035/5-3mm MWCE-35-5/3-TORNADO		10
G10417	Tornado Platinum Coils/.035/7-3mm MWCE-35-7/3-TORNADO		10
G10413	Tornado Platinum Coils/.035/10-5mm MWCE-35-10/5-TORNADO		10
G26994	Nester Platinum Coils/.035/6mm MWCE-35-14-6-NESTER		10
G26995	Nester Platinum Coils/.035/8mm MWCE-35-14-8-NESTER		10
G26991	Nester Platinum Coils/.035/10mm MWCE-35-14-10-NESTER		10
G26992	Nester Platinum Coils/.035/12mm MWCE-35-14-12-NESTER		10
Snares, Hatch Medical, Inc (Angiotech)			
Catalog #	**Description**		**Quantity**
392006010	EN SNARE/6-10mm		5
392006020	EN SNARE/12-20mm		5
Dilators, Cook Medical			
Catalog #	**Description**		**Quantity**
G10284	AQ® Hydrophilic/6F JCD6.0-35-20-HC		5
G102898	AQ® Hydrophilic/6F JCD8.0-38-20-HC		5
Constrast/Thrombolytics (usually available in standard pharmacy/OR packs)			
Catalog #	**Description**		**Quantity**
	Omnipaque 180		10
	Tenektase (tPA)		10

APPENDIX E: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Ventilator Associated Pneumonia (VAP) (CPG ID:45)

To establish guidance for the prevention and mitigation of Ventilator Associated Pneumonia (VAP)

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GOAL

The goal of this Clinical Practice Guideline (CPG) is to provide guidance for the diagnosis, treatment, prevention, and mitigation of Ventilator Associated Pneumonia (VAP). These guidelines are not intended solely for clinical care, but also to help unit commanders and supporting medical components to consider the unique challenges of the management of a common healthcare associated infection in both traditional and expeditionary settings.

BACKGROUND

VAP is a common healthcare-associated infection (HAI), but what defines VAP and how it is diagnosed have remained moving targets. Due to wide variations in the surveillance and diagnosis of VAP, the true rate of VAP is unknown, but it is believed to occur in at least 5-15% of patients placed on a ventilator.[1-2]

While much of combat casualty care in the intensive care unit setting is largely similar to the care of trauma patients in civilian centers, there are several challenges unique to expeditionary care, chief among them being microbiological variabilities. Military operations in Iraq and Afghanistan are notable for a high number of multi-drug resistant (MDR) bacterial infections in combat casualties, particularly Acinetobacter calcoaceticus-baumannii complex (ABC).[3]

Several benchmark studies, along with other data, implicate nosocomial transmission as the major contributing source of these infections.[4-6] *An outbreak of multi-drug resistant Acinetobacter baumannii-calcoaceticus complex infections in the U.S. military health-care system associated with military operations in Iraq* described cluster outbreak strains of ABC within the military healthcare system suggesting that, at least in the case of ABC, the bacteria has spread from field hospitals in Iraq to those within the continental U.S.[7] Additionally, bacteria identical to those found in clinical isolates have been cultured from numerous environmental surfaces from U.S. medical treatment facilities within Iraq. These experiences have been replicated in more recent times with similar results, indicating that this issue is endemic and not related to individuals or groups of service members.

DIAGNOSIS

The diagnosis of VAP is difficult and varies across institutions. American Thoracic Society and Infectious Disease Society of America guidelines define VAP as a "new lung infiltrate plus clinical evidence that the infiltrate is of an infectious origin, which include the new onset of fever, purulent sputum, leukocytosis, and decline in oxygenation" which develops >48 hours after endotracheal intubation.[8]

Determination of whether a pulmonary abnormality is of infectious origin is particularly challenging, especially in trauma patients. Blast injury and penetrating chest injury patients are highly likely to have injury-related chest radiography findings that may obscure or mimic infections.

Patients on mechanical ventilation are at risk for a variety of serious complications in addition to VAP, including acute respiratory distress syndrome, pneumothorax, pulmonary embolism, lobar atelectasis, and pulmonary edema. The Centers for Disease Control have large scale, ongoing quality projects designed to validate and streamline surveillance measures, though these have yet to be validated for a priori diagnosis of various ventilator associated conditions. Despite the changing language surrounding ventilator associated conditions, the strongest and most consistent evidence continues to support daily

sedation interruptions and spontaneous breathing trials for aggressive liberation from mechanical ventilation as the factors most likely to reduce all ventilator associated conditions.[9]

PROPHYLACTIC MEASURES

GENERAL MEASURES:

1. Conduct active surveillance for ventilator associated conditions,[10] including but not limited to:
   - Ventilator associated pneumonia
   - Pulmonary edema
   - Acute respiratory distress syndrome
   - Atelectasis
2. Perform daily assessments of readiness for extubation including:
   - Daily sedation interruptions for patients in whom it is not contra-indicated (e.g., severe cerebral edema).
   - Protocoled conduction of spontaneous breathing trials for all patients meeting the following criteria:

   Required criteria

   a. The cause of the respiratory failure has improved.

   b. PaO2/FiO2 ≥150 or SpO2 ≥90 percent on FiO2 ≤ 50 percent and positive end-expiratory pressure (PEEP) ≤ 8 cmH2O

   c. pH >7.25

   d. Hemodynamic stability (no or low dose vasopressor medications)

   e. Able to initiate a spontaneous inspiratory effort.

   Additional criteria (optional criteria)

   a. Hemoglobin ≥7 mg/dL

   b. Core temperature ≤38 to 38.5°Centigrade

   c. Mental status awake and alert or easily arousable with ability to protect airway.

STAFF EDUCATION PRIORITIES

1. Epidemiology of Ventilator Associated Events
2. Infection-control procedures for prevention of VAP

   a. Avoid intubation and utilize non-invasive ventilation when possible.

   b. ABCDEF bundle[11] (see Appendix C)

   c. VAP bundle components and use[12] (See below.)

3. Periodic audits of the use of guidelines with aggressive education and enforcement of procedures.

VAP BUNDLE COMPONENTS

RESPIRATORY EQUIPMENT MANAGEMENT

Breathing Circuits with Humidifiers

Change the circuit when it is visibly soiled or mechanically malfunctioning. Do not routinely change on the basis of duration of use of the breathing circuit (i.e. ventilator tubing and exhalation valve and the attached humidifier) that is in use on an individual patient.

Breathing Circuit/Tubing Condensation

Periodically drain and discard any condensation that collects in the tubing of mechanical ventilators, taking precautions not to allow condensation to drain toward the patient. Wear gloves to perform the procedure and/or when handling the fluid. Decontaminate hands with soap and water (if hands are visibly soiled) or with an alcohol-based hand solution before and after performing the procedure or handling the fluid.

Humidifiers

Use sterile (not distilled, nonsterile) water to fill bubbling humidifiers. Between the uses of reusable hand-powered resuscitation bags on different patients, sterilize or subject to high-level disinfection. Do not routinely sterilize or disinfect the internal machinery of anesthesia equipment. Between uses on different patients, clean reusable components of the breathing system or patient circuit (e.g., tracheal tube or face mask) inspiratory and expiratory breathing tubing, y-piece, reservoir bag, humidifier, and tubing, and then sterilize or subject them to high-level liquid chemical disinfection or pasteurization in accordance with the device manufacturers' instructions for their reprocessing.

Keep all ventilators covered when not in use to reduce dust accumulation on devices.

PREVENTION OF PERSON-TO-PERSON TRANSMISSION OF BACTERIA

Cohorting

Implement patient and staff cohorting whenever possible by using geographically distinct areas of care. In the deployed setting, this includes separating Host National from non-Host National patient due to differences in the microbiomes. Disinfect all patient care equipment after each patient transfer. Terminally clean rooms between patients and consider periodic (monthly) ICU/ICU subunit closure for thorough cleaning and disinfection. In deployed settings, this should be conducted as regularly as field conditions permit.

Standard Precautions

Decontaminate hands by washing either with antimicrobial soap and water (if hands are visibly dirty or contaminated with blood or body fluids), or by using an alcohol-based waterless antiseptic agent if hands are not visibly soiled. Use personal protective equipment based on clinical circumstance.

Contact precautions with gloves and gown for all patient contact for patients infected or suspected with epidemiologically significant pathogens, specifically MDR Acinetobacter spp., ESBL-producing Klebsiella spp. and Escherichia coli, carbapenem-resistant Enterobacteriaceae, vancomycin-resistant Enterococcus spp., and methicillin-resistant Staphylococcus aureus. Decontaminate hands before and after patient contact and use gloves as below.

Gloves

Wear gloves for handling secretions or objects contaminated with secretions of any patient. Change gloves and decontaminate hands as described previously between contacts with different patients. When anticipating becoming soiled from secretions, wear a gown and change it after soiling occurs and before providing care to another patient.

Care of patients with Tracheostomy

Perform tracheostomy care under aseptic conditions. When changing a tracheostomy tube, wear a gown and mask, use aseptic technique. Providers should familiarize themselves with manufacturers recommendations regarding the quality and frequency recommended for tracheostomy care. Additionally, the life expectancy of inner cannula is variable depending on the product used (e.g., 24h to 29 days). Tracheostomy care orders should be written specific to the product used.

Suctioning of respiratory tract secretions

Appropriate to use either the multiuse closed system suction (Ballard) catheter or the single-use open system suction catheter. Patients persistently on the ventilator should have a Ballard system in line, while those intermittently on or off the ventilator with a tracheostomy in place can have the open suction employed as appropriate. If the open-system suction is employed, use a sterile, single-use catheter and sterile technique when suctioning. Use only sterile fluid to remove secretions from the suction catheter if the catheter is to be used for re-entry into the patient's lower respiratory tract.

PREVENTION OF MUCUS PLUGGING (ENDOTRACHEAL TUBE)

- If feasible, use an endotracheal tube (Hi Lo Tube) with a dorsal lumen above the endotracheal cuff to allow drainage of tracheal secretions that accumulate in the patient's subglottic area.
- Before deflating the cuff of an endotracheal tube in preparation for extubation, ensure that secretions are cleared from above the tube cuff.

PREVENTION OF ASPIRATION RELATED INFECTION (GASTROINTESTINAL)

- Head of bed elevation: In the absence of contraindication(s), elevate the head of bed at an angle of 30° to 45° of a patient at high risk for aspiration (e.g., traumatic brain injury, mechanically assisted ventilation).
- As soon as the clinical indications for their use are resolved, remove devices such as endotracheal, tracheostomy, and/or enteral tubes from patients.
- Feeding tube verification: Verify appropriate placement of the feeding tube prior to use.
- Due to recent studies questioning the value and safety[12] of chlorhexidine-based oral care, this guideline does not advocate for the routine use of chlorhexidine-based oral decontamination.

Routine oral hygiene with a tooth brush or oral sponge should continue to be provided with the goals of removal of dental plaque and other debris from teeth, tongue and oral mucosa.

PREVENTION OF POSTOPERATIVE PNEUMONIA

- Encourage all postoperative patients to take deep breaths, move about the bed, and ambulate unless medically contraindicated.
- Use incentive spirometry on postoperative patients.
- Incorporate rehabilitation therapy as early as possible in the post-operative period.
- Antibiotic therapy:
  - Surgical prophylaxis: Minimize the duration and spectrum of surgical antibiotic prophylaxis in accordance with the JTS Infection Prevention Clinical Practice Guideline, 08 Aug 2016.13
  - Suspected infection: Initial therapy should be broad spectrum and informed by each facility's antibiotic susceptibility patterns, if available. When possible, cultures should be obtained prior to initiation of antibiotic therapy. Infectious Disease Society of America guidelines state that non-invasive sampling with semi-quantitative cultures is the preferred methodology. Therapy should be tailored based on culture results and should be given for a 7 day course.14

AEROMEDICAL EVACUATION CONSIDERATIONS

1. Aeromedical Evacuation from any AOR to CONUS can require multiple flights over the course of days before the patient arrives at his or her final destination.
2. All patients, including those on mechanical ventilation, will experience a decrease in PaO2 as ambient pressure decreases.
   - Patients with marginal gas exchange will require additional support during flight.
   - Cabin altitude restriction will lessen the impact on gas exchange.
3. All ventilated patients should have the head of bed elevated at least 30° unless there is a contraindication.
4. All ventilated patients require gastric decompression prior to flight. Barring specific surgical indications for nasal placement, orogastric tube is preferred to nasogastric tube to prevent sinusitis.
5. If NPO or not tolerating fluids, consider adding IV fluids to help prevent dehydration during flight. Consider increasing maintenance IV rate due to dry air at altitude and increased rate of insensible loss.
6. Consider repeat CXR prior to flight if > 12 hours has elapsed since most recent one or clinical condition has changed significantly.
7. Do not extubate patient less than 4 hours prior to take off.
8. Consider enteral nutrition according to JTS Nutritional Support Using Enteral and Parenteral Methods CPG.[15] Tube feeds not administered through a small bowel feeding tube should be discontinued prior to flight.

9. Patients with decreased mobility require routine Deep Venous Thrombosis prophylaxis. See the JTS CPG The Prevention of Deep Venous Thrombosis – Inferior Vena Cava Filter, 02 Aug 2016.[16]
    - If anatomically feasible, sequential compression devices should be used.
    - Enoxaparin 30mg sq BID or heparin 5000 IU sq q8h may be used as chemoprophylaxis providing patient does not have potential hemorrhagic issues.
10. Gastric ulcer prevention should be provided if indicated

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients receiving mechanical ventilation.

INTENT (EXPECTED OUTCOMES)

- Incidence of VAP is tracked in each ICU and for the system as a whole.
- Mechanically ventilated patients receive VAP bundle.

PERFORMANCE/ADHERENCE METRICS

- Number and percentage of mechanically ventilated patients who develop VAP, tracked for each role 3 and 4 separately and overall for the system as a whole.
- Number and percentage of patients who have daily sedation interruption and spontaneous breathing trial or contraindication documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the Joint Trauma System (JTS) Director, JTS Program Manager, and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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APPENDIX A: VENTILATOR-ASSOCIATED EVENTS SURVEILLANCE ALGORITHM

Patient has a baseline period of stability or improvement on the ventilator, defined by ≥ 2 calendar days of stable or decreasing daily minimum* FiO_2 or PEEP values. The baseline period is defined as the 2 calendar days immediately preceding the first day of increased daily minimum PEEP or FiO_2. *Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour.

After a period of stability or improvement on the ventilator, the patient has at least one of the following indicators of worsening oxygenation:
1) Increase in daily minimum* FiO_2 of ≥ 0.20 (20 points) over the daily minimum FiO_2 of the first day in the baseline period, sustained for ≥ 2 calendar days.
2) Increase in daily minimum* PEEP values of ≥ 3 cmH_2O over the daily minimum PEEP of the first day in the baseline period† , sustained for ≥ 2 calendar days.
*Daily minimum defined by lowest value of FiO_2 or PEEP during a calendar day that is maintained for > 1 hour. †Daily minimum PEEP values of 0-5 cmH_2O are considered equivalent for the purposes of VAE surveillance

Ventilator-Associated Complication (VAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, the patient meets both of the following criteria:
1) Temperature > 38 °C or < 36°C, OR white blood cell count ≥ 12,000 cells/mm^3 or ≤ 4,000 cells/mm^3
2) A new antimicrobial agent(s) (see Appendix B for eligible antimicrobial agents) is started, and is continued for ≥ 4 qualifying antimicrobial days.

Infection-related Ventilator-Associated Complication (IVAC)

On or after calendar day 3 of mechanical ventilation and within 2 calendar days before or after the onset of worsening oxygenation, ONE of the following criteria is met (taking into account organism exclusions specified in the protocol):
1) Criterion 1: Positive culture of one of the following specimens, meeting quantitative or semi-quantitative thresholds† as outlined in protocol, without requirement for purulent respiratory secretions:
- Endotracheal aspirate, ≥ 10^5 CFU/ml or corresponding semi-quantitative result
- Bronchoalveolar lavage, ≥ 10^4 CFU/ml or corresponding semi-quantitative result
- Lung tissue, ≥ 10^4 CFU/g or corresponding semi-quantitative result
- Protected specimen brush, ≥ 10^3 CFU/ml or corresponding semi-quantitative result

2) Criterion 2: Purulent respiratory secretions (defined as secretions from the lungs, bronchi, or trachea that contain >25 neutrophils and <10 squamous epithelial cells per low power field [lpf, x100])† **PLUS** organism identified from one of the following specimens (to include qualitative culture, or quantitative/semi-quantitative culture without sufficient growth to meet criterion #1):
- Sputum
- Endotracheal aspirate
- Bronchoalveolar lavage
- Lung tissue
- Protected specimen brush

3) Criterion 3: One of the following positive tests:
- Organism identified from pleural fluid (where specimen was obtained during thoracentesis or initial placement of chest tube and NOT from an indwelling chest tube)
- Lung histopathology, defined as: 1) abscess formation or foci of consolidation with intense neutrophil accumulation in bronchioles and alveoli; 2) evidence of lung parenchyma invasion by fungi (hyphae, pseudohyphae or yeast forms); 3) evidence of infection with the viral pathogens listed below based on results of immunohistochemical assays, cytology, or microscopy performed on lung tissue
- Diagnostic test for Legionella species
- Diagnostic test on respiratory secretions for influenza virus, respiratory syncytial virus, adenovirus, parainfluenza virus, rhinovirus, human metapneumovirus, coronavirus

† If the laboratory reports semi-quantitative results, those results must correspond to the quantitative thresholds.

Possible Ventilator-Associated Pneumonia (PVAP)

APPENDIX B: ANTIMICROBIALS AGENTS ELIGIBLE FOR IVAC, PVAP

Antimicrobials Agents Eligible for IVAC, PVAP	
1. Amikacin	35. Gentamicin
2. Amphotericin B	36. Imipenem/Cilastatin Isavuconazonium
3. Amphotericin B Liposomal	37. Itraconazole
4. Ampicillin	38. Levofloxacin
5. Ampicillin/Sulbactam	39. Linezolid
6. Anidulafungin	40. Meropenem
7. Azithromycin	41. Meropenem/Vaborbactam
8. Aztreonam	42. Metronidazole
9. Baloxavir Marboxil	43. Micafungin
10. Caspofungin	44. Minocycline
11. Cefazolin	45. Moxifloxacin
12. Cefepime	46. Nafcillin
13. Cefotaxime	47. Omadacycline
14. Cefotetan	48. Oritavancin
15. Cefoxitin	49. Oseltamivir
16. Ceftaroline	50. Oxacillin
17. Ceftazidime	51. Penicillin G
18. Ceftazidime/Avibactam	52. Peramivir
19. Ceftolozane/Tazobactam	53. Piperacillin
20. Ceftriaxone	54. Piperacillin/Tazobactam
21. Cefuroxime	55. Plazomicin
22. Ciprofloxacin	56. Polymyxin B
23. Clarithromycin	57. Posaconazole
24. Clindamycin	58. Quinupristin/Dalfopristin
25. Colistimethate	59. Rifampin
26. Dalbavancin	60. Sulfamethoxazole/Trimethoprim
27. Delafloxacin	61. Tedizolid
28. Doripenem	62. Telavancin
29. Doxycycline	63. Tetracycline
30. Eravacycline	64. Tigecycline
31. Ertapenem	65. Tobramycin
32. Fluconazole	66. Vancomyin, Intravenous Only
33. Fosfomycin	67. Voriconazole
34. Gemifloxacin	68. Zanamivir

APPENDIX C: ABCDEF BUNDLE

A: Assess, prevent and manage pain

B: Both Spontaneous Awakening Trials (SAT) and Spontaneous Breathing Trials (SBT)

C: Choice of analgesia and sedation

D: Delirium: Assess, Prevent and Manage

E: Early mobility and exercise

F: Family engagement and empowerment (challenging in the deployed environment)

The ABCDEF Bundle: Science and Philosophy of How ICU Liberation Serves Patients and Families, Ely EW, Crit Care Med. 2017 February; 45(2): 321–330

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

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ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

War Wounds: Debridement and Irrigation (CPG ID:31)

This CPG reviews indications for and the procedures associated with battle related wound debridement and irrigation, and associated initial wound management strategies for penetrating war wounds.

** Interim and Preliminary Update **

Final version is pending. For questions about this CPG, contact dha.jbsa.healthcare-ops.list.jts-pips@health.mil

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SUMMARY OF CHANGES

- Inclusion of tetanus and antibiotic prophylaxis.
- Early identification and treatment of wounds at high risk for invasive fungal infection.
- Inclusion of antibiotic powder as an option for wound prophylaxis and contrasting effect of negative pressure wound therapy on local antibiotic delivery in wounds using polymethyl methacrylate (PMMA) antibiotic beads and antibiotic powder.
- Revision of section on a retained foreign object (RFO).

BACKGROUND

Wound debridement and irrigation (D&I) is the most frequently performed surgical procedure in the combat theater.[1] Given the power of war munitions, prompt removal of nonviable tissue, debris, blood and bacteria is imperative to prevent local and systemic complications associated with such a wound.[2] Appendix A outlines the injury patterns and resulting physiology from weapons of war. Care must be given to ensure all nonviable tissue is removed, while at the same time preserving as much soft tissue as possible for reconstructive surgery at higher echelons of care.[3] Balancing these two competing factors often necessitates serial D&I. While there are a variety of different therapeutic options of varying efficacy, no one approach is perfect for all situations.

***NOTE**: Related CPGs: Invasive Fungal Infection in War Wounds, Acute Traumatic Wound Management in the Prolonged Field Care Setting, Infection Prevention in Combat-Related Injuries. CPGs can be viewed/downloaded from https://jts.health.mil/index.cfm/PI_CPGs/cpgs.*

EVALUATION AND TREATMENT

IMMEDIATE PROPHYLACTIC MEASURES

U.S. Service Members should routinely receive tetanus toxoid and single-dose IV antibiotic (typically Ancef) for war wounds. Host nation patients or those with unclear vaccination histories should receive toxoid, Ancef and tetanus immune globulin. (Refer to *Infection Prevention in Combat-Related Injuries CPG*).

DEBRIDEMENT

Thorough inspection of the wounds with liberal use of surgical enlargement (i.e. wide surgical exposure) is necessary to inspect all levels of tissue, including examination of fascial planes and the integrity of neurovascular structures. This may require extension to outside the zone of trauma. When extending the wound into healthy tissue, consideration should be given to how this could potentially affect future reconstructive or closure options.[4] In general, extremity wounds should be extended in a longitudinal manner (parallel with the bone) and truncal wounds should be extended along Langer's lines (see figure below). Wound configuration and need for additional vascular exposure must be considered and this may at times violate all of the above precepts.

Figure 1. Langer Lines

Source: Integrated Activities in Primary Care – Minor Surgery in Family Medicine. IntechOpen. 11 May 2016

It is critical that the wartime surgeon has an appreciation for the phenomenon of wound evolution and weapon ballistics. Military assault rifles and proximity blasts cause large areas of cavitation because the kinetic energy transfer exceeds the area of tissue destruction by the projectile.[5] Such wounds are known to appear viable or questionably viable but progress to necrosis over the subsequent 24-72 hours from microvascular thrombosis and ischemia. Blast wounds are heavily contaminated with environmental debris and, sometimes, foreign tissue from other blast victims. Furthermore, regional vascular injury, tourniquet use, hemorrhagic shock, and persistent critical illness also diminish the capacity for wound healing and lead to disappointing evolution of the war wound. Therefore, avoid closure of wounds after the first washout or within the first 48 hours. Premature wound closure causes severe morbidity from necrotizing infection, often invisible on external exam until late in the process. Appendix A outlines the injury patterns and resulting physiology from weapons of war.

Surgeons should anticipate the need to frequently re-inspect and perform serial D&I on extensive soft tissue wounds.[3] While there is not a strict guideline defining the time sequence of repeat D&I, a general rule is frequent inspections in the operating room (every 24 hours) until all non-viable tissue has been debrided while all other tissues are confidently viable. This prevents overly aggressive removal of questionably viable tissue at the early debridements while still aggressively addressing progression of necrosis. Once such wounds have stabilized with absence of nonviable tissue, inspections can be separated in time by 2 days or more until a final wound closure strategy is identified. Strategies include healing by secondary intent, delayed primary closure, split thickness skin graft, or tissue transfer. Patient movement decisions should be adapted to the requirements of surgical management – not the converse. When possible, ensure that a planned D&I is done within 24 hours prior to patient movement

to ensure the receiving team has adequate time to assess and schedule follow-on wound care. In general, leave the wound open until arrival at the definitive care facility.

It is recognized that unstable blast injury patients with multiple fragmentation injuries over much of their bodies may not be able to undergo thorough debridement of all wounds at initial operation; this can be due to instability, lack of resources, lack of personnel, or urgency of transfer. It is therefore important that extent and adequacy of what debridement has been done is documented to guide further treatment at receiving facilities.

Sharp surgical debridement is the mainstay of care for war wounds; irrigation is an adjunct, but in no way replaces debridement for removal of non-viable tissue in wounds. Meticulous sharp debridement using a scalpel and/or scissors should be a starting point for most wartime wounds. Assurance of hemostasis and removal of all nonviable skin, fat, fascia, muscle, and bone are essential to reduce the load of contamination and necrotic tissue prior to dressing application.[4]

The need for repeat serial inspection and wound debridement cannot be over-emphasized. Unstable blast injury patients with multiple fragmentation injuries may not receive thorough debridement of all wounds at initial operation due to resuscitation needs, lack of resources, lack of personnel, or urgency of transfer. Always document the extent and adequacy of debridement performed as well as debridements still required. When receiving a patient from a forward role of care within the first 24 hours of injury, urgent operative re-exploration of all wounds is a best practice. Pre-operative CT scan is an important adjunct to identify areas of radiopaque debris or soft tissue air. These serve as a signal for areas of occult injury, residual contamination or necrosis that guides the next debridement.

IRRIGATION

There are several acceptable devices available for wound irrigation. Simple bulb syringe irrigation and gravity irrigation are the preferred methods. Large bore gravity-fed tubing is favored for irrigations requiring large fluid volumes, such as those associated with contaminated open fractures. Cystoscopy tubing connected to a 3 liter saline bag is ideal for gravity irrigation of large or multiple wounds. Pulsatile jet lavage irrigation using a battery powered system is not associated with improved outcomes but increases expense, weight, and space.[6,7] All methods of wound irrigation are adjuncts and not substitutes to sharp surgical debridement.

The current recommendations for volume of irrigation are as follows:

- 1-3 liters for small volume wounds.
- 4-8 liters for moderate wounds.
- 9 or more liters for large wounds or wounds with evidence of heavy contamination.

This takes into account that bacterial loads drop logarithmically with increasing volumes of irrigation. Depending on the environment and medical logistics support, the volume of sterile fluids may not be available. Normal saline, sterile water and potable tap water all have comparable efficacy and safety as irrigation solutions.[8,9] The inclusion of irrigation fluid additives such as iodine, bacitracin or antibiotics is without proven benefit.[7]

WOUND DRESSINGS

While wet-to-dry dressings are a mainstay for the management of open traumatic wounds, negative pressure wound therapy (NPWT) has become the more common and frequently preferred method for large soft tissue wounds. The principals of wound care are cleanliness and micro debridement. Wet-to-dry dressings, when done properly, achieve both; dressings keep the wound moist and provide mechanical debridement when removed. If the wound is too wet, it will not debride. If the wound is too dry, then it will impede healing. Optimal wound care management with wet to dry dressing requires the dressing to be changed every 12-24 hours; more frequent dressings may be needed, depending on the wound's size, exudate burden, contamination, and vascularity. The use of either normal saline, sterile water, or potable water for the dressing are equally efficacious. This strategy for wet-to-dry dressings may need be adapted to a dry-to-wet dressing in a highly exudative/weeping wound. For highly contaminated wounds, the use of Dakin's solution has been suggested to decrease the rates of invasive fungal infections (IFI); however, the sodium hypochlorite may be toxic to macrophages, fibroblasts and neutrophils.[10,11]

NPWT with Reticulated Open Cell Foam (NPWT/ROCF), commonly referred to as the VAC (vacuum assisted closure therapy system) dressing, is a commonly used alternative to wet-to-dry dressings. NPWT dressing can be left in place up to 72 hours depending on the extent and acuity of the wound. Utilization of NPWT requires a hemostatic wound bed and absence of purulence. The VAC Therapy System comes with a default negative pressure setting of 125mmHg. For large wound volumes, the pressure setting can be increased and/or an additional suction pad may be placed and connected with a "Y" connector. NPWT may aggravate bleeding in wounds with challenging hemostasis or venous hypertension. Clotted blood visible through the plastic covering or high amounts of dark sanguineous output indicate a need to return to the OR for hemostasis. Foam should not come into physical contact with exposed vessels. Use of VAC therapy has been proven safe and stable for long range air evacuation transports.[12]

The use of NPWT offers several advantages over wet-to-dry dressings. NPWT allows for accurate measurement of fluid loss from the wounds, prevents fluid soilage on linens and gurneys, obviates the need for painful bedside dressing changes, and promotes granulation tissue. However, there are many pitfalls that must be avoided with the placement of NPWT. It is imperative in large or deep wounds that all the ROCF is in contact with the suction source. If a piece of sponge in the wound is isolated from suction, bacteria will grow from fluid stasis. This especially applies to amputations from blasts where cavities track between muscle groups. In the unanticipated event of prolonged care at a Role 2 location, NPWT can be improvised without needing to stock commercial VAC supplies. NPWT can be devised using any suction source, Kerlex roll gauze, a conduit like a nasogastric tube (with the blue sump port tied in a knot), and an occlusive dressing like Ioban. The improvised VAC technique is further described in the *JTS Acute Traumatic Wound Management in the Prolonged Field Care Setting CPG*.[9]

IFI CONSIDERATIONS

IFIs are opportunist infections which tend to occur at the far end on the spectrum of war wound severity. IFIs are so devastatingly morbid and lethal they have their own CPG (*Invasive Fungal Infections in War Wounds*). However, because there are clinical factors that can predict wounds at greatest risk for IFI and because the irrigation and dressings for these wounds should be managed differently from what has been mentioned above (using Dakin's solution), these differences will be highlighted here.

During the first debridement, assess patients for IFI risk factors:

- Dismounted blast injury
- Above knee immediate amputation
- Extensive perineal/genitourinary/rectal injury
- Massive transfusion of >20 units in the first 24 hours (or anticipation of 20 units)

If three of the above factors are present, switch irrigation to high-volume Dakin's solution and dressings should be wet-to-dry using Dakin's solution. Furthermore, because IFI also occurs with wounds not initially meeting the criteria listed above, additional criteria seen after subsequent debridement should also prompt the same change to Dakin's irrigation and dressings.

Look out for these additional IFI risk factors on subsequent inspections of wounds not previously considered at risk of IFI:

- Progression from below-knee to through-knee to above-knee amputation
- Recurrent necrosis following at least two consecutive debridements

(Refer to the *Invasive Fungal Infection in War Wounds CPG* for more discussion of steps taken at Roles 3, 4 and 5 for suspected IFI.)

EVACUATION CONSIDERATIONS

It is critical that the down-range surgeon be mindful of timing of D&I with casualty evacuation. To avoid extended periods without wound inspection due to fixed wing flight, a best practice is to anticipate movement and plan debridement within 24 hours of movement. Generally, large acute wounds will need inspection and D&I every 24 hours during the first few days after injury. Ideally, serial D&I should be completed by the same provider, and photo documentation of wounds obtained (in compliance with theater policy); however, the nature of patient evacuation may result in rapid transport from the point of injury to the Role 1, 2 and 3 in a compressed timeline. Most wounds should not be closed prior to arrival at a definitive care location. Providers receiving a patient with a closed wound should have a relatively low threshold to reopen a wound if there are any concerns for contamination or non-viable tissue having been left behind. This compulsive approach to combat soft tissue injuries will decrease the likelihood that a wound will worsen and result in adverse patient outcomes.

CLOSURE

War wounds are contaminated and frequently result from high velocity injuries. Unless they occur from mechanisms other than battle injury, war wounds should not be treated with primary wound closure in the deployed setting. Though no hard rules exist for the closure of battle injuries, wartime experience demonstrates four broad categories of wound outcome:

1. Healing by secondary intention
2. Delayed primary closure with or without drain placement
3. Split thickness skin graft over local soft tissue
4. Tissue transfer with subsequent split thickness skin graft

Which of these four closure strategies is best suited for any given wartime soft tissue injury is left to the discretion of the surgical team.

ANTIBIOTIC BEADS

Placement of antibiotic impregnated PMMA can be used as an adjunct to D&I to deliver increased local antibiotic concentrations while minimizing the associated side effects of high systemic loads of these antibiotics. Indications include contamination with open fractures and traumatic amputations, treatment of established osteomyelitis, and dead space management with associated soft tissue defect. Animal models demonstrate a PMMA bead pouch is more effective without NPWT because the antibiotic remains in the wound without collecting in the vacuum canister.[13] The PMMA beads are usually prepared on a suture or wire and laid within the wound and covered with a semipermeable membrane, forming a bead pouch. Typically reserved for Role 3 and 4 use, a PMMA bead pouch may be used in conjunction with NPWT. It may be helpful to place the antibiotic beads in the deep portion of the wound and not in direct contact with the reticulated open cell foam to allow stasis of antibiotics concentrations in the wound. The choice of antibiotic should be directed by the local antibiogram. Common antibiotics include heat stable powder formulations of tobramycin, vancomycin, imipenem, and colistin. Recent evidence also supports prefabricating and sterilely packaging PMMA beads for subsequent use, allowing for bead use in a multi-casualty/time constrained setting. The efficacy of this adjunct is supported by several small studies and case series which, in aggregate, suggest this can lead to a 10% or greater absolute decrease in wound infections.[14] Further research is needed on its use in combat trauma patients. Recent epidemiologic studies by the Trauma Infectious Disease Outcomes Study Group showed an increased rate of osteomyelitis when PMMA antibiotic beads were used.[15-17] These results should be viewed cautiously as they did not control for confounding factors (such as selection bias that the beads were used or patients at a higher baseline risk of developing osteomyelitis).

ANTIBIOTIC POWDER

There is a groundswell of interest in use of topical antibiotic powders (TAP) for prophylaxis in wounds with contaminated fractures. Recent large animal studies comparing TAP and antibiotic PMMA beads in wounds treated with NPWT show that TAP achieves higher sustained wound concentrations and is more effective at curbing bacterial growth.[18] Analysis of the collected NPWT drainage indicates about half of the antibiotic is removed with suction, indicating that the amount of powder can be increased when used in conjunction with NPWT. A recent prospective randomized multicenter trial of 980 patients with tibial plateau or pilon fractures at high risk of infection showed a 33% relative risk reduction in deep surgical site infection (SSI) using 1gm of topical vancomycin powder immediately before wound closure. Analysis of the infecting organisms showed that the difference in overall infection rate was directly attributable to gram positive sensitivity to vancomycin, with a 50% relative risk reduction in gram positive deep SSI and no effect on gram negative deep SSI. Fractures without soft tissue coverage or with combined vascular injuries were excluded from enrollment.[19] There is insufficient data at this time to advocate widespread antibiotic powder use during serial debridement of war wounds with concomitant fracture.

RFO PREVENTION

An RFO event refers to an iatrogenic event in which a sponge or surgical instrument is deliberately or unintentionally left behind while the wound proceeds to definitive management. Both surgical and traumatic open wounds are at risk for RFOs. Several features unique to the deployed environment place patients at increased risk of this complication. Among these risk factors are multiple surgical teams performing procedures on multiple wounds simultaneously, multiple surgeons performing procedures at different times, instrument and sponge counts being omitted in hemodynamically unstable patients, patients undergoing care at multiple different treatment facilities, and minimal documentation on operative records. The most obvious example of this would be definitive closure of the abdomen with a retained lap sponge. A less obvious vignette would be deliberate temporary hemostatic closure of a thigh compartment over Combat Gauze unrecognized by subsequent surgical teams at higher roles of care. Even with a slower operational tempo, RFO events continue to happen as these are two examples of true events occurring in Iraq and Afghanistan within the last 5 years. The deployed environment is high risk for RFO events because of the frequency of severe injuries requiring staged operations with temporary packing for hemostasis, multiple locations with multiple surgical teams, limited OR support for sponge and instrument counts during exigent circumstances, and communication challenges during patient hand-offs between roles of care. Strategies must be undertaken to mitigate these risks.

Best practices include:

1. The medical record must reflect any material that has been purposefully left in the wound.

2. Physician-to-physician communication (preferably surgeon-to-surgeon) should occur if foreign bodies remain in the wound.

3. There should be a low threshold to obtain radiographs to confirm removal of all foreign bodies. This is particularly important for cases in which a sponge and instrument count were omitted due to hemodynamic instability, discrepancies during the closing or final sponge an instrument count, or when a wound is being closed by a different surgeon at a subsequent treatment facility. Ideally, the images should be reviewed by both the surgeon and radiologist before closing the wound and leaving the operating room. The use of radiofrequency-labeled sponges and detectors is an adjunct to improve detection of retained sponges, but does not remove the need to use x-rays to definitively clear a cavity of sponges. Not only is it possible that a forward role of care used non-RFID lap sponges, but combat gauze can be used to control challenging intracavitary bleeding and will only be detected on x-ray.

FACIAL WOUNDS

While traumatic facial wounds are treated in a similar fashion to wounds in other areas of the body, some aspects of facial wound management deserve special attention. Maxillofacial wounds sustained in combat typically involve both soft tissue and other structures including bone, teeth, cartilage, mucosa-lined structures (sinuses, mouth, etc.), eyes and the cranial vault. As such, maxillofacial wound management may be more complicated than soft tissue wounds in other parts of the body, and may warrant multidisciplinary care. Facial wounds and their management can significantly impact the patient's airway, vision, and ability to speak and eat. Severe injuries to the midface or mandible may necessitate immediate airway control.

The robust, redundant blood supply of the facial region promotes healing and reduces the incidence of wound infection compared to the trunk and extremities. As with other wounds, the first step in facial wound management involves excellent hemostasis, profuse irrigation, and meticulous debridement. All clearly non-viable tissue must be sharply excised. Threatened but potentially viable tissue should be maintained – especially around the eyes. Given the rich vascular supply of this region, it is better to conserve as much tissue as possible during the initial debridement as opposed to aggressive, wide debridement. Primary closure, while contraindicated in wounds in other areas of the body, is acceptable for many wounds of the face. Consider use of fast-absorbing sutures in any patient with unreliable follow up. Large areas of missing tissue may be covered temporarily with dressings, taking care to keep the tissues moist. Consider local or regional flaps in the acute phase when there is exposed bone or cartilage. In high velocity injuries, the surgeon should conserve as much tissue as possible during the first surgery and allow the wound to demarcate. After several days of wound care, the resulting defect can be repaired using a musculocutaneous flap.[20] Most importantly, the surgeon must cover all exposed bone and cartilage with vascularized tissue and an appropriate antibiotic ointment to prevent infections in these structures.

The use of NPWT/ROCF has not been well documented in the treatment of facial wounds but may be appropriate in some situations where there is extensive tissue loss. If a cerebrospinal fluid leak is suspected, this should be avoided. Foreign bodies, along with damaged bone and cartilage lacking periosteum and perichondrium, should be removed while carefully preserving the remaining viable tissues to the greatest extent possible. Antibiotics should be used for all facial wounds associated with sinus, nasopharyngeal or oropharyngeal injuries. Injuries to cartilaginous structures (i.e. ears, nose) are especially susceptible to Pseudomonas aeruginosa and Staphylococcus aureus infections. (Refer to the *Infection Prevention in Combat-Related Injuries CPG*.)

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with wounds requiring debridement and irrigation within 1 day of injury.

INTENT (EXPECTED OUTCOMES)

- Combat wounds are treated with sharp surgical debridement, augmented by irrigation, at the first surgical role of care, or reason for delay documented.
- Combat wounds remain open after initial operation (excluding face and scalp wounds).

PERFORMANCE/ADHERENCE MEASURES

- Number and percentage of patients in population of interest who received sharp debridement of combat wounds at the first surgical role of care.
- Number and percentage of patients in the population of interest who have wounds left open at the initial operation (excluding face and scalp wounds).

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

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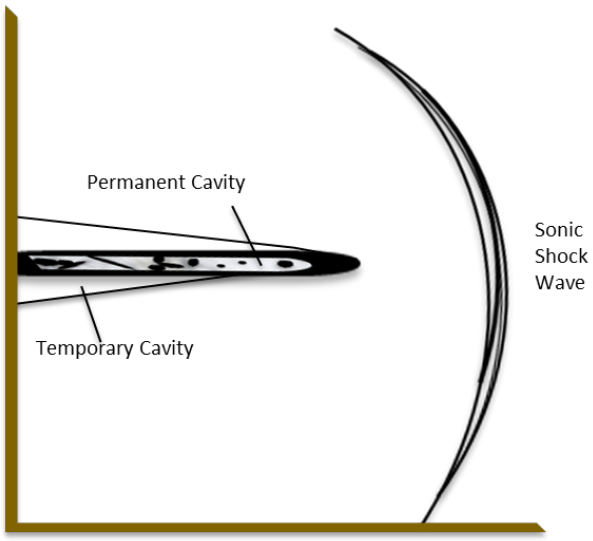
APPENDIX A : WEAPON EFFECTS

Military munitions and firearms produce injuries not commonly seen in civilian trauma. Weapon types can be roughly divided into two major subtypes: small arms fire and explosive munitions. Small arms fire is typically from hand guns and assault rifles.[1]

When a small arms projectile hits tissue, it produces two types of injuries: a permanent cavity and a temporary cavity. The permanent cavity is the tissue destroyed by the actual pathway of the projectile. Military rounds are designed to turn, or yaw, upon contacting tissue. As the bullet turns, the permanent cavity size increases. This is evidenced by small entry wounds and large exit wounds. A second, temporary cavity occurs from a pressure wave created by the high-velocity round. Elastic, and inelastic tissue, is put under stress which manifests as delayed necrosis and is one of the reasons we do not advocate for wound closure following the initial debridement. The degree of damage is proportional to a projectile's kinetic energy and more specifically its velocity (Kinetic Energy = ½ (Mass) x Velocity). Particles distributed by blast explosions also create permanent and temporary cavities.

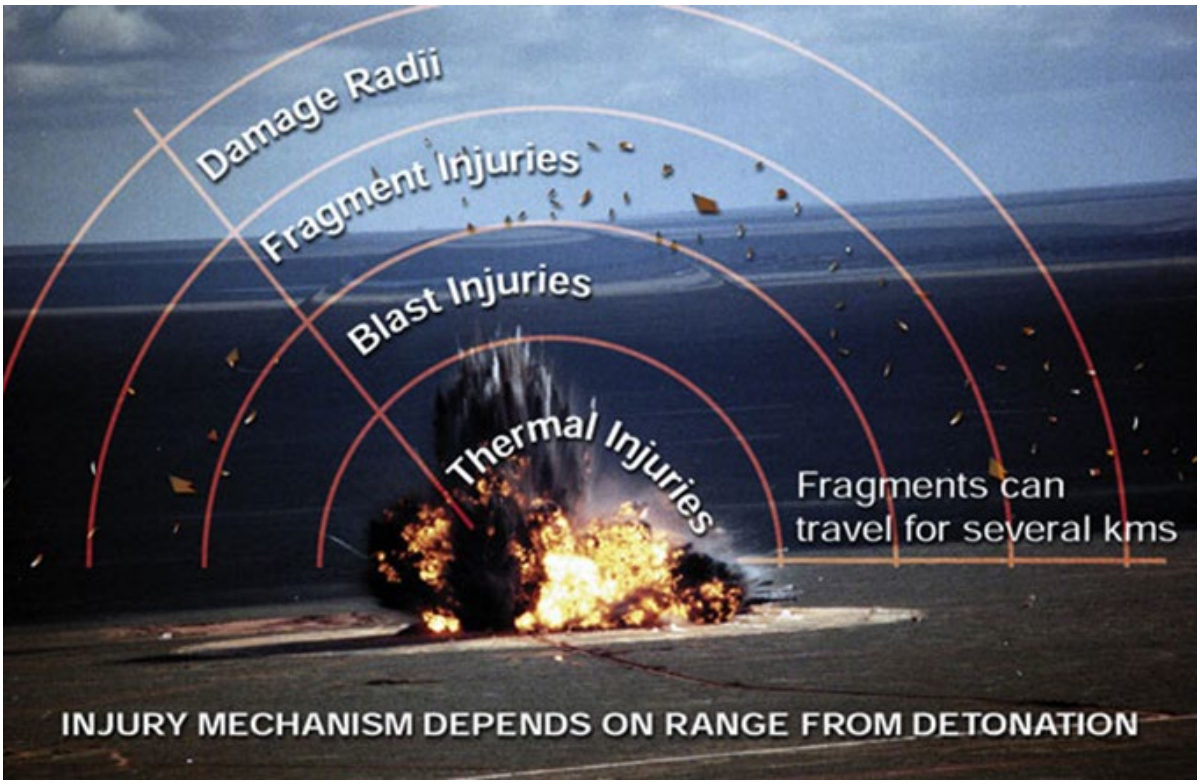
Figure A-1. Two areas of projectile-tissue interaction



Explosive munitions injure through four major mechanisms. The number of mechanisms a person is exposed to depends on their distance from the explosion, with persons closer to blasts being exposed to more mechanisms of injury. (See Figure 2 below.) Primary blast injuries occur from a pressure wave known as a blast wave. The blast wave can sheer off tissue, damage solid organs, and damage hollow viscus injuries from pressure changes in the air contained within the organs. These injuries may manifest several days after the blast and are typically discovered on serial examinations of the injured patient. Secondary blast injuries are penetrating injuries which result from particles contained within the munition or from debris from the surrounding environment distributed by the blast. Tertiary blast injuries comprise two subtypes of injury. The first is a negative pressure wave called a blast wind which follows the positive pressure of a blast wave. Similar injuries are produced by both blast wind and blast waves. The second subtype of injury is blunt trauma resulting from large objects being projected into a body, or a person's body being projected into the surrounding environment, like a wall or the ground. When a blast hits a vehicle, occupants are susceptible to being injured by sequential pressure waves as they reflect around the inside of the vehicle. Quaternary blast injuries also comprise two major subtypes. The first subtype is burn injuries, which are treated as outlined in the JTS Burn Care Clinical

Practice Guideline. The second are CBRNE injuries (Chemical, Biological, Radiological, Nuclear, and Environmental Injuries) and are managed as outlined in CBRNE guidelines.

Figure A-2. Four mechanisms of blast injury



Virtually every organ is susceptible to injury from blast explosions and many of these injuries, particularly hollow viscus injuries and soft tissue necrosis, present in a delayed format, necessitating serial exams and clinical awareness.

Reference: Cubano, M.A., et. al. Chapter 1: Wespons Effects and War Wounds. Emergency War Surgery, 5th United States Revision. Fort Sam Houston, TX: Borden Institute, 2018.

APPENDIX B: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Wartime Thoracic Injury (CPG ID:74)

The goal of this CPG is to provide guidance on the diagnosis, initial treatment, and surgical management of thoracic injuries in the deployed or operational environment.

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BACKGROUND

Thoracic injuries are present in 12 to 50% of civilian trauma patients.[1] Over 90% of these civilian injuries are due to a blunt mechanism, and less than 10% require surgical intervention.[2] In contrast, significant thoracic trauma is present in only 10% of combat-injured patients, but the great majority of cases are associated with penetrating mechanism.[3,4] The most common thoracic injuries are pneumothorax, pulmonary contusion, and chest wall trauma, whereas injuries to the lung or great vessels have the highest mortality rate.[3] Tube thoracostomy is indicated as an initial diagnostic and therapeutic intervention for the majority of patients with thoracic trauma. For more severe injuries, thoracotomy (primarily anterolateral), sternotomy, or other surgical approach may be indicated on an emergency basis.

ROLES OF CARE AND THORACIC INJURY

Each role of care has unique approaches to the management of thoracic trauma:

- **Role 1:** The focus is treatment or stabilization of immediate life-threatening thoracic injuries, such as airway obstruction, and tension pneumothorax. Follow the Tactical Combat Casualty Care guidelines for treatment of chest trauma.[5]
- **Role 2:** Care is focused on resuscitation and damage control surgical procedures. Tube thoracostomy placement is a critical diagnostic and therapeutic intervention. Anterolateral thoracotomy or sternotomy may be required for acutely bleeding patients.
- **Role 3:** Definitive surgical treatment should be attempted for most injuries, with the possible exception of complex tracheobronchial or great vessel injuries.
- **Role 4:** Definitive therapy.

Table 1. Summary Recommendations for the Management of Thoracic Injuries

Summary Recommendations for the Management of Thoracic Injuries
1. Tube thoracostomy is indicated as the initial therapeutic intervention for most patients with penetrating thoracic trauma, and for any patient with suspected significant pneumothorax/hemothorax. At the Role 1 level, needle decompression is indicated for suspected tension pneumothorax.
2. Intrapericardial cardiac or great vessel injury should be suspected in any patient with penetrating thoracic or upper abdominal trauma, and generally can be diagnosed using ultrasonography or surgical pericardial window.
3. Left anterolateral thoracotomy (resuscitative thoracotomy) is the incision of choice in any penetrating thoracic trauma patient who is in extremis or profoundly unstable, who loses vital signs immediately before arrival, or has an observed loss of vital signs. This should be combined with right tube thoracostomy or extension of the thoracotomy to a clamshell if a mediastinal or right chest injury is suspected.
4. For a patient with palpable pulses and penetrating chest wound with hemopericardium, sternotomy is usually the preferred initial incision. If the diagnosis of hemopericardium is uncertain, sternotomy should be preceded by subxiphoid pericardial window.
5. The management of suspected subclavian vascular injuries is complex and technically demanding, and may require a combination of sternotomy, anterior thoracotomy, and supra/infraclavicular incisions.
6. For patients with suspected esophageal perforation, tracheobronchial injury, or blunt great vessel injury, the initial focus should be on stabilization, temporary control and wide drainage, rather than definitive repair.
7. For unstable patients with significant combined thoracic and abdominal trauma, exploratory laparotomy should be combined with bilateral tube thoracostomy and trans-diaphragmatic pericardial window to allow for a complete assessment and treatment of major injury.
8. Patients undergoing surgical intervention for acute thoracic trauma should be approached in the supine position and prepped for multiple potential incisions with a low threshold for additional incisional exposure to control life-threatening injuries. Posterolateral thoracotomy is rarely indicated in the acute trauma setting.
9. Observation of a small pneumothorax is not appropriate for any patient undergoing prolonged transport. In cases where clinical or radiographic findings are equivocal, clinicians should err on the side of tube thoracostomy prior to transport.
10. In rare circumstances, the use of Extra-Corporeal Membrane Oxygenation may be needed in the setting of a complex thoracic injury resulting in severe hypoxia, hypercapnia, or heart failure. For ECMO referrals 24/7, contact (210) 916-ECMO/DSN (312) 429-ECMO (leave message if not answered immediately); alternate contact is SAMMC operator at (210) 916-2500/DSN (312) 429-2500.

DIAGNOSIS OF THORACIC INJURIES

As with all trauma patients, the evaluation of a patient with thoracic trauma begins with a determination of airway patency, adequacy of breathing, hemodynamic stability, and neurological status. Where available, ultrasound and chest X-ray are useful diagnostic adjuncts.

PNEUMOTHORAX, HEMOTHORAX

1. In a patient with thoracic trauma and a clinically patent airway who has rapid, inadequate, or labored respirations, the diagnosis of pneumothorax must be assumed until proven otherwise.

2. Absent or markedly decreased breath sounds in a patient with known thoracic trauma indicate the need for intervention without additional diagnostic testing. In addition to treating pneumothorax or hemothorax when present, tube thoracostomy may be diagnostic of these conditions based on a rush of air or blood after tube placement.

3. In a patient with normal hemodynamics and adequate oxygenation and ventilation, it is reasonable to confirm a pneumothorax by chest X-ray or ultrasound prior to tube thoracostomy.

TENSION PNEUMOTHORAX

1. Signs and symptoms of tension pneumothorax include severe or progressive shortness of breath or hemodynamic compromise in the setting of chest trauma.

2. Differentiating between a simple pneumothorax and a tension pneumothorax is based on the presence of hemodynamic effects (hypotension and decreased perfusion) in the latter condition. While a patient with thoracic trauma and a pneumothorax may present with multiple injuries and an alternate explanation for hypotension (such as cardiac tamponade, intraabdominal bleeding, or hemothorax), immediate needle or tube thoracostomy is the necessary first step in this scenario. In the case of a tension pneumothorax, this maneuver should have both diagnostic and therapeutic benefit.

3. Patients who are hypovolemic are more susceptible to the hemodynamic effects of tension pneumothorax.

OPEN PNEUMOTHORAX (SUCKING CHEST WOUND)

Open pneumothorax occurs when a defect in the chest wall is sufficiently large to impair effective air exchange (air will preferentially pass through the defect if larger than 2/3 the tracheal diameter). In the case of an open pneumothorax due to a large chest wall defect, the diagnosis will be clinically obvious on physical examination.

RIB FRACTURES, FLAIL CHEST

1. Rib fractures are a clinical diagnosis based on chest wall pain and point tenderness (with or without crepitus) in the setting of blunt or penetrating chest wall trauma.

2. Maintain a high index of suspicion for associated injuries (pulmonary contusion, pneumothorax, splenic or liver laceration, etc.).

3. Rib fractures are associated with pneumothorax, hemothorax, solid abdominal organ injury, and thoracic great vessel injury. Patients must be assessed for these associated injuries.

4. Flail chest may be diagnosed clinically by gross chest wall instability or paradoxical chest wall movement with respiration. Practically, the differentiation between rib fractures alone and a flail

segment is not important, as the initial management is the same for both conditions. The morbidity of this type of injury is determined by the underlying pulmonary contusion which may impair gas exchange and the consequences of low lung volumes due to pain.

PULMONARY CONTUSION

1. Pulmonary contusion is most common with blunt trauma or blast injury.

2. Patients with pulmonary contusion may present with respiratory distress and reduced breath sounds on the injured side. Often, symptoms may not manifest immediately after injury. Chest X-ray may show patchy opacity(s). However, lung contusion is primarily a clinical diagnosis.

3. It can be difficult to differentiate between pulmonary contusion and pneumothorax when imaging is not available. In this scenario, if the patient is significantly symptomatic and does not improve with initial pain management, one must assume that pneumothorax is present, and tube or needle thoracostomy is indicated (particularly prior to transport).

CARDIAC TAMPONADE

1. For low-velocity penetrating injuries, the possibility of intra-pericardial cardiac or great vessel injury should be considered when there is penetrating trauma in the “box” defined by the space inferior to the clavicles, superior to the costal margin and medial to the mid-clavicular line.

2. With high velocity gunshot wounds and multiple penetrating blast fragment wounds, intra-pericardial damage is possible with any penetrating injury to the chest or upper abdomen.

3. Ultrasound assessment is a rapid, simple, and widely available tool to assess for significant hemopericardium, which indicates intra-pericardial injury in this setting. When a hemopericardium and hypotension co-exist in a patient with significant trauma (of any mechanism), no further diagnostic evaluation is indicated. However a negative pericardial ultrasound in penetrating chest trauma does not definitively rule out cardiac injury or pericardial blood as sometimes blood can drain from the pericardium into either the right or left chest if there is a hole in the pleural pericardium.

4. Classic physical exam findings of tamponade (distended neck veins, muffled heart sounds) are not reliable.

5. In a hypotensive patient undergoing exploratory laparotomy for penetrating abdominal injury, a trans-diaphragmatic pericardial window is a rapid means to evaluate for hemopericardium/tamponade.

GREAT VESSEL INJURY

1. Most combat-related great vessel injuries are fatal at the point of injury.

2. In some cases, particularly after major blunt trauma, a patient may present with a contained great vessel injury associated with a mediastinal hematoma. Although a widened mediastinum on plain chest X-ray may be suggestive of this injury, computed tomographic angiography is necessary for

diagnosis. Other X-ray findings suggestive of great vessel injury include apical capping, tracheal deviation, wide paratracheal stripe, and downward deviation of the left main bronchus.

3. If a contained great vessel injury is suspected (mediastinal hematoma), such an injury is unlikely to acutely cause hypotension, and other causes of bleeding and hypotension should be sought.

ESOPHAGEAL PERFORATION

1. Esophageal perforation is a rare injury since the esophagus is protected in the posterior mediastinum. It may be suspected due to wound trajectory, and occurs most often in association with other penetrating injuries.

2. The diagnosis is commonly delayed and there should be high index of suspicion for this rare injury depending on mechanism of injury and fragment trajectories. The diagnosis may be suspected or confirmed after placement of a tube thoracostomy for a pleural effusion/hemothorax. Contents of the drainage may contain gastrointestinal contents.

3. Endoscopy, esophagram and/or computed tomographic (CT) scan can confirm the diagnosis.[6]

TRACHEOBRONCHIAL INJURIES

1. Penetrating proximal thoracic tracheobronchial injuries are rarely encountered due to their proximity to the great vessels and heart and subsequent lethality.

2. Diagnosis requires a high index of suspicion. The most common diagnostic signs are subcutaneous emphysema, pneumothorax and hemoptysis. Hoarseness and dysphonia are also common symptoms. Respiratory failure, the presence of a pneumothorax on chest X-ray, or a large air leak after tube thoracostomy are typical but non-specific findings.

3. If there is concern for a tracheobronchial injury, bronchoscopy should be performed with documentation of injury location and severity of injury.[7] The most common locations are in the distal trachea and proximal mainstem bronchi (within 2cm of the carina).

DIAPHRAGMATIC INJURIES

1. Diaphragm injuries commonly occur with high energy blunt trauma or penetrating thoracoabdominal injuries. Diaphragm injury should be considered in any thoracoabdominal penetrating trauma.

2. Auscultation of bowel sounds in the chest are highly suggestive of diaphragm injury but are rarely identified. On ultrasound exam, bowel may be seen in the chest. If there is concern for diaphragm injury, placement of a nasogastric tube with subsequent chest X-ray may confirm the diagnosis.

3. Small diaphragm injuries typically go undetected until direct examination of the diaphragm at the time of surgery (laparotomy, laparoscopy, thoracotomy, thoracoscopy). A high index of suspicion for diaphragm injury should be maintained for penetrating wounds to the left and right upper quadrant.

4. Diaphragm injuries may allow blood from the abdomen to be drawn into the negative pressure region of the chest. In this case, abdominal bleeding may present as a hemothorax.

INITIAL MANAGEMENT FOR THORACIC TRAUMA

The most important early priority in the treatment of a patient with thoracic trauma is assessment and treatment for injuries that may be immediately life-threatening (listed below). Tube thoracostomy is often indicated in a severely injured thoracic trauma patient, and will generally provide useful clinical information (and potential treatment) regardless of diagnosis.

TENSION PNEUMOTHORAX

1. Clinical suspicion of tension pneumothorax requires rapid treatment, either with needle decompression and subsequent tube thoracostomy, or with immediate tube thoracostomy. The choice between these two alternatives depends on the immediate availability of thoracostomy supplies, the patient's condition, and the experience of the person performing the procedure.

2. Needle decompression should be performed with a large bore (14 gauge or larger) 3.25in/8cm catheter in the 4th or 5th intercostal space, anterior axillary line. The alternate needle decompression site is the 2nd intercostal space at the mid-clavicular line (this is the primary site in children). Ensure dedicated needle decompression catheters are available with all emergency medical supplies; shorter (5cm) catheters used for venous access should be avoided as these will rarely penetrate the thoracic cavity and thus be ineffective.

3. Needle decompression alone is insufficient treatment for a pneumothorax and certainly ineffective for hemothorax and should in most cases be followed by placement of a tube thoracostomy as soon as feasible and safe. For stable patients who have undergone needle thoracostomy, evaluation with ultrasound or chest X-ray to assess the need for chest tube placement is appropriate.

4. If tube thoracostomy placement is delayed, providers should be prepared to repeat needle decompression as needed. Failure to improve after two needle decompressions most likely indicates an alternative diagnosis to pneumothorax (e.g., hemothorax, pulmonary contusion, and diaphragm injury).

5. Tube thoracostomy is performed using blunt/open technique, as described in Appendix A: Specific Thoracic Procedures.

OPEN PNEUMOTHORAX

Initial management with placement of a vented chest seal is reasonable until a tube thoracostomy can be performed.

MASSIVE HEMOTHORAX

1. The return of blood under pressure or a large volume of blood after tube thoracostomy indicates significant intra-thoracic injury.

2. Parenchymal lung injuries are the most common source of hemothorax, but massive hemothorax is likely due to a chest wall vascular injury, hilar pulmonary injury, or great vessel/cardiac injury.

3. With the immediate return of 1,500ml of blood after tube thoracostomy, thoracotomy is indicated. When the initial blood loss is below 1,500mL but significant bleeding continues (more than 200-250ml/hr and/or ongoing transfusion requirements), thoracotomy is also indicated.

4. In a patient with hemothorax due to penetrating injury and loss (or impending loss) of vital signs during or immediately prior to arrival, emergency resuscitative thoracotomy is indicated. (See the JTS Emergency Resuscitative Thoracotomy CPG.[8])

5. All patients with massive hemothorax will require damage control resuscitation and massive blood product transfusion (as outlined in respective CPGs).

6. Anterolateral thoracotomy is the best approach for massive hemothorax in an acute trauma patient. Although a posterolateral thoracotomy (ideally with lung isolation) may provide more optimal exposure, it presents limitations if additional incisional exposure is needed, may place the contralateral lung at risk for aspiration, and requires positioning maneuvers that may be challenging in a bleeding, acutely injured patient.

7. If after ipsilateral anterolateral thoracotomy, an intra-pericardial injury is encountered, conversion to a clamshell (bilateral thoracosternotomy) incision (described below) is indicated.

8. If a proximal left subclavian injury is encountered after left anterolateral thoracotomy, conversion to a trapdoor incision (described below) is an option to improve exposure.

9. In patients with penetrating trauma to the torso, a high suspicion must be maintained for bleeding in the other body cavities (opposite chest or abdomen).

10. Autotransfusion of shed pleural blood using a chest tube collection system and autotransfusion accessory can be considered.[9]

SUSPECTED CARDIAC OR GREAT VESSEL INJURY

1. Cardiac tamponade due to combat trauma requires immediate surgical intervention.

2. Fluid resuscitation may temporarily stabilize a patient in tamponade.

3. Pericardiocentesis (ultrasound guided, if available) combined with blood transfusion may help temporize a patient until arrival to a surgical capability,[10] recognizing that blood re-accumulation is likely.

4. Patients with suspected isolated great vessel injury (contained mediastinal hematoma) should receive pain control. If hemodynamics allow, this should be followed by a short-acting beta blocker (e.g., esmolol drip) to prevent tachycardia and hypotension.

RIB FRACTURES, FLAIL CHEST

1. In the absence of associated massive or ongoing bleeding into the pleural space, there is no role for surgical intervention for blunt chest wall injury. The major clinical significance of blunt chest wall injury in most cases is the potential for associated contusion of the underlying lung, which can have a major detriment on oxygenation and pulmonary status.

2. If physical exam or chest X-ray suggests the possibility of pneumothorax or hemothorax, immediate tube thoracostomy is indicated. In cases where clinical or radiographic findings are equivocal, clinicians should err on the side of tube thoracostomy prior to transport.

3. The treatment of rib fractures and flail chest includes pain control, close monitoring, oxygenation and ventilatory support as needed. Consider local and regional anesthetics in addition to systemic pain medications.

THORACIC TRACHEOBRONCHIAL INJURY

1. Initial management is aimed at ensuring adequate oxygenation and ventilation.

2. Tube thoracostomy is an important early intervention. If negative pressure suction through a tube thoracostomy worsens respiratory function due to a large air leak, the tube should be taken off of suction and placed to water seal. An alternative is connecting the chest tube to a one-way Heimlich valve.

3. If one chest tube does not re-inflate the lung, then a second chest tube should be placed.

4. Advancing an endotracheal tube into the right mainstem bronchus may help manage a significant tidal volume loss from left-sided injuries.

5. Other maneuvers, when available, include the use of bronchial blockers or double lumen endotracheal tube.

EXTRA CORPOREAL MEMBRANE OXYGENATION (ECMO)

1. ECMO may allow oxygenation for problematic injuries, and the DoD ECMO team should be contacted early if this is considered. For ECMO referrals 24/7 contact: (210) 916-ECMO/DSN (312) 429-ECMO (leave message if not answered immediately); alternate contact SAMMC operator at (210) 916-2500/DSN (312) 429-2500. DoD ECMO team members can also be reached by email at: usarmy.jbsa.medcom-bamc.list.ecmo@health.mil.

2. For specific ECMO indications, refer to the JTS Acute Respiratory Failure CPG.[11]

SURGICAL MANAGEMENT OF THORACIC TRAUMA

1. A patient with thoracic trauma for whom acute surgical intervention is planned has a life-threatening injury by definition. Therefore, the patient should be positioned to maximize options for necessary interventions: supine with arms out, prepped from chin to knees and chest to elbows. Large-bore access (IV, IO, or central venous) should be in place, and the airway secured with a cuffed endotracheal tube.

2. For a patient with penetrating thoracic trauma who is in extremis or who is profoundly unstable, left anterolateral thoracotomy is the incision of choice and should be combined with right tube thoracostomy. This incision can be extended across the midline (as a “clamshell” incision) for suspected intra-pericardial injury or right pleural space bleeding.

3. For a patient with palpable pulses and penetrating chest wound with hemopericardium, sternotomy is usually the preferred initial incision. If the diagnosis of hemopericardium is uncertain (ultrasound is unavailable or equivocal but there is a high clinical suspicion for cardiac injury), sternotomy should be preceded by subxiphoid pericardial window.

4. The management of subclavian vascular injuries is challenging. For suspected proximal left subclavian arterial injury, left anterior thoracotomy in the third interspace is a safe initial incision for proximal control. Proximal control of the right subclavian artery is best achieved via median sternotomy. Intravascular balloon

occlusion is an additional option to obtain proximal control of injuries to the great vessels. Refer to the JTS Vascular Injury CPG for further details.[12]

5. For repair of a subclavian artery injury after proximal control, the left or right proximal to mid-subclavian artery can be exposed via a supraclavicular incision. An infraclavicular incision provides exposure to the more distal subclavian artery and the subclavian vein. For more complex subclavian vascular injuries, a trapdoor incision will provide maximal exposure.

6. Lung parenchymal injuries should be resected in a non-anatomic fashion if possible. Anatomic resections should be performed only if the entire lobe has been damaged and is not salvageable. Trauma pneumonectomy should only be performed with non-salvageable hilar injuries and is associated with an extremely high mortality.

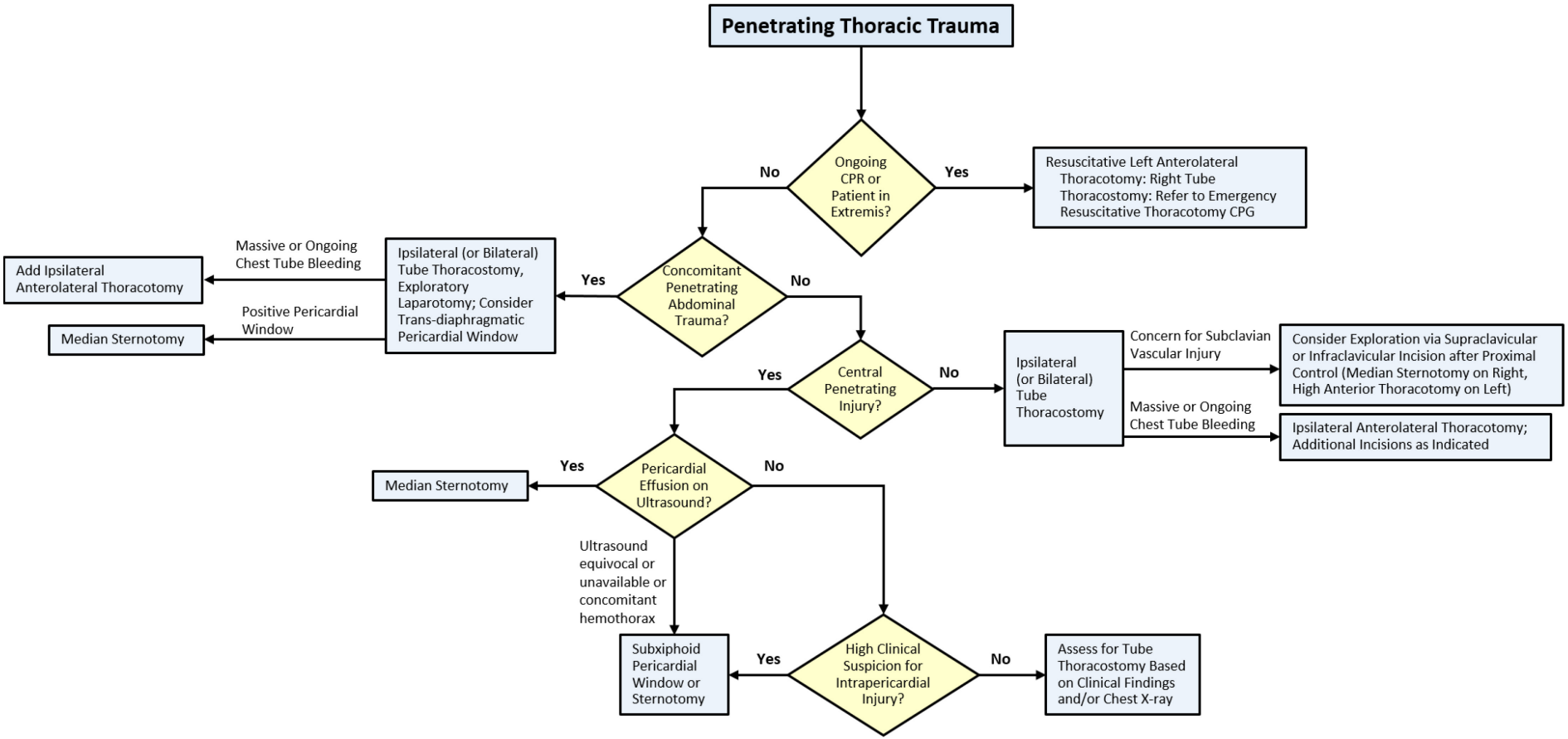
7. Posterolateral thoracotomy is rarely appropriate in the acute trauma setting. It is not appropriate in the damage control setting since it does not allow extension into frequently injured adjacent body cavities (abdomen, neck). It may be indicated for definitive repair of posterior mediastinal or lung injuries in a well-resuscitated patient after other injuries have been excluded or addressed.

8. In a patient with combined penetrating chest and abdominal trauma with hemodynamic instability, rapid insertion of bilateral chest tubes and midline laparotomy with pericardial window through the anterior diaphragm will allow for assessment of bleeding from all major body cavities. When needed, laparotomy can be extended to a sternotomy (for a positive pericardial window) or a separate anterolateral thoracotomy incision can be performed for ongoing pleural space hemorrhage. When the diaphragm is lacerated, an abdominal source of bleeding may present as bleeding into the chest cavity.

9. As described below, damage control philosophy and strategies apply to emergency thoracic surgery as well. Gauze packing and hemostatic adjuncts can help achieve temporary hemostasis of chest wall defects or injuries at the apex of the hemithorax.[13] Uncontrolled bleeding from the lung, pulmonary hilum or thoracic aorta can be packed as well.[14] Due to risk of iatrogenic tamponade, avoid packing of the pericardium.

10. Temporary chest closure can be considered after damage control procedures, or when there is concern for thoracic compartment syndrome due to massive resuscitation. Closure can be performed using a negative pressure vacuum closure or simply a large adhesive drape with a large-bore chest tube for drainage and suction.[14]

Figure 1. Algorithm for Surgical Management of Penetrating Thoracic Trauma


Penetrating Thoracic Trauma
Ongoing CPR or Patient in Extremis?
No
Yes
Resuscitative Left Anterolateral Thoracotomy: Right Tube Thoracostomy: Refer to Emergency Resuscitative Thoracotomy CPG
Concomitant Penetrating Abdominal Trauma?
Yes
No
Ipsilateral (or Bilateral) Tube Thoracostomy, Exploratory Laparotomy; Consider Trans-diaphragmatic Pericardial Window
Massive or Ongoing Chest Tube Bleeding
Add Ipsilateral Anterolateral Thoracotomy
Positive Pericardial Window
Median Sternotomy
Central Penetrating Injury?
Yes
No
Ipsilateral (or Bilateral) Tube Thoracostomy
Concern for Subclavian Vascular Injury
Consider Exploration via Supraclavicular or Infraclavicular Incision after Proximal Control (Median Sternotomy on Right, High Anterior Thoracotomy on Left)
Massive or Ongoing Chest Tube Bleeding
Ipsilateral Anterolateral Thoracotomy; Additional Incisions as Indicated
Pericardial Effusion on Ultrasound?
Yes
No
Median Sternotomy
Ultrasound equivocal or unavailable or concomitant hemothorax
Subxiphoid Pericardial Window or Sternotomy
High Clinical Suspicion for Intrapericardial Injury?
Yes
No
Assess for Tube Thoracostomy Based on Clinical Findings and/or Chest X-ray

DAMAGE CONTROL TECHNIQUES [14-18]

1. The goals of damage control surgery, hemorrhage and contamination control, are the same regardless of location of injury. While hemorrhage control remains paramount in damage control thoracic surgery, contamination from the alimentary tract is infrequently encountered from esophageal injuries. Damage control surgery is a staged approach to life-threatening injury. As applied to thoracic surgery in the combat setting, damage control surgery consists of:

    a. Rapid transport from point of injury to a higher level of care and recognition of need for DCS (Role 2,3).

    b. Rapid control of hemorrhage and contamination (Role 2,3).

    c. Resuscitation with restoration of physiology in intensive care setting (Role 2-4).

    d. Return to surgery for completion of operative repairs (Role 3, 4).

    e. Definitive chest closure (Role 3, 4).

2. Packing may be used as a complement to hemostatic efforts for hemorrhage from the chest wall, lung, and vascular structures that have been repaired. When packing, no pressure should be placed on the heart or major, low-pressure vasculature (i.e. superior vena cava, inferior vena cava, pulmonary artery).

3. There is a stepwise increase in mortality with more extensive resections when lung injuries are encountered. Tractotomy and limited wedge resection are associated with higher survival rates compared to lobectomy. Trauma pneumonectomy carries the worse prognosis with mortality rates ranging from 50-100%.

4. Pulmonary tractotomy is performed by opening a through-and-through injury tract with a gastrointestinal anastomosis (GIA) stapler (or between straight vascular clamps) followed by control of the bleeding edges and/or air leaks with additional staplers or a running suture repair using a non-cutting needle.

5. Damage control surgical techniques to temporarily control massive hilar hemorrhage include: the hilar twist maneuver, temporary hilar clamping, and intra-pericardial control of the ipsilateral main pulmonary artery with a Rommel tourniquet. These techniques should be prioritized in an effort to defer or avoid pneumonectomy.

6. A pneumonectomy may be warranted in unstable patients with massive parenchymal destruction, massive hilar hemorrhage, or extensive bronchial disruption beyond repair.

7. Acute right heart failure is the most common cause of death after trauma pneumonectomy. Rapid increases in pulmonary vascular resistance/pressure lead to increased right ventricular end diastolic pressure followed by shifting of the interventricular septum leftward, which ultimately leads to left ventricular dysfunction. Principles of treatment center on judicious volume resuscitation, inotropic support, and reduction in pulmonary vascular resistance and right ventricular afterload. Early ECMO team contact is indicated.

8. Medications

    - Dobutamine and milrinone provide positive inotropic effects and serve as moderate pulmonary vasodilators, lowering right ventricular afterload while improving function.
    - Inhaled nitric oxide (20-40 ppm through the ventilator) is a pure pulmonary vasodilator that also improves right ventricular function by lowering right ventricular afterload. These medications are typically only available in the Role 4 setting or higher.

9. Cardiac injury may be associated with intra-cardiac valve or septum injury. Maintain a high-index of suspicion for injury to more than one cardiac structure or hidden, intra-cardiac injuries.

10. Cardiac bleeding after penetrating injury can be controlled initially with a skin stapler or Foley balloon.

11. Open cardiac massage should be performed by compressing the heart between two flat hands from the apex towards the outflow tracts.

12. Temporary chest closure should be considered in the damage control setting or if there is concern for thoracic compartment syndrome (increased intrathoracic pressure causing decreased venous return and decreased cardiac output). It is performed in a manner similar to that of temporary abdominal closure. Thoracostomy tubes (or mediastinal drains) and sterile surgical towels or gauze are placed, followed by placement of an occlusive dressing. Negative pressure is then applied to the temporary closure. A wound vacuum system can also be utilized in this setting. When a vacuum sponge closure is used, direct contact between the sponge and lung tissue should be avoided.

13. Timing for return for definite chest closure is determined by adequacy of resuscitation and normalization of physiologic parameters, as evidenced by reversal of triad of hypothermia, acidosis, and coagulopathy.

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

All patients with chest injury of AIS code 2 or greater.

INTENT (EXPECTED OUTCOMES)

1. All patients in the population of interest with diagnosis of hemothorax or pneumothorax receive a tube thoracostomy prior to transport from the first surgical capability.

2. Patients in the population of interest who do not have a diagnosis of hemothorax or pneumothorax do not receive a tube thoracostomy.

3. In patients who receive needle decompression of the chest, the specific reason that tension pneumothorax was suspected is documented.

4. Patients with massive hemothorax > 1,500 ml undergo thoracotomy at the first surgical capability.

5. E-FAST results are documented in all patients with significant chest injury (AIS code 2 or greater).

PERFORMANCE/ADHERENCE METRICS

1. Number and percentage of patients in the population of interest with diagnosis of hemothorax or pneumothorax who had a tube thoracostomy placed prior to transport from the first surgical capability.

2. Number and percentage of patients in the population of interest who do not have hemothorax or pneumothorax who had a tube thoracostomy placed.

3. Number and percentage of patients who receive needle decompression of the chest who have the specific reason for suspected tension pneumothorax documented.

4. Number and percentage of patients who undergo thoracotomy or sternotomy at the first surgical capability, who have the indication for the procedure clearly documented.

5. Number and percentage of patients with significant chest injury (AIS code 2 or greater) who have E-FAST results documented.

DATA SOURCES

- Patient Record
- Department of Defense Trauma Registry (DoDTR)

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and the JTS PI Branch.

RESPONSIBILITIES

It is the trauma team leader's responsibility to ensure familiarity, appropriate compliance and PI monitoring at the local level with this CPG.

REFERENCES

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APPENDIX A: SPECIFIC THORACIC PROCEDURES [19,20]

TUBE THORACOSTOMY

1. Antibiotic prophylaxis (with gram positive coverage) should be given prior to tube thoracostomy to reduce infectious complications, provided this will not lead to a clinically significant delay in treatment. [21, 22]

2. There is no need to position the ipsilateral arm over the patient's head.

3. If time allows, prep the anterior and lateral chest on the affected side and administer antibiotics prior to incision.

4. Plan an incision at nipple level (male) or at the inframammary crease (female), centered over the anterior axillary line.

5. Infiltrate local anesthesia for a stable, awake patient.

6. After a generous transverse incision (2-4cm) into the sub-dermal fatty tissues, a curved clamp is used to bluntly dissect the muscle and soft tissue down to the level of the rib. A blunt clamp is then directed over the top of the rib into the pleural space. A rush of air or blood out of the chest will confirm a pneumothorax or hemothorax respectively.

7. The clamp should be spread within the chest wall, followed by digital palpation to confirm pleural space entry, and insertion of a chest tube in an apical and posterior direction.

8. For combat trauma injuries, a chest tube size of at least 24-french is appropriate. In the setting of known or suspected hemothorax, a tube size of at least 28-french is desirable to reduce the risk of tube occlusion from clotted blood.

9. After the tube is sutured securely to the skin, it should be attached to a closed drainage system. In the field setting, a one-way Heimlich valve may be used for temporary drainage.

SUBXIPHOID PERICARDIAL WINDOW

1. Only appropriate for a stable patient. Prep the patent widely for potential sternotomy and/or thoracotomy.

2. After a 4–6 cm vertical midline incision centered over the xiphoid process, dissect through the skin and fascia with knife or electrocautery.

3. The xiphoid process can then be grasped/lifted with a Kocher clamp or can be excised with a heavy scissor or with electrocautery to facilitate exposure.

4. Blunt dissection deep to the xiphoid, directed in a cephalad direction will expose fatty tissue over the anterior pericardium. If the diaphragm is encountered, the dissection should be redirected in a more cephalad direction.

5. After removing or dissecting this fatty tissue to expose the underlying whitish pericardium, the pericardium should be grasped with a forceps or clamp and sharply incised.

6. Any gross blood in the pericardial space indicates a positive pericardial window and mandates sternotomy.

7. Clear pericardial fluid indicates no injury. Occasionally, absence of pericardial fluid may indicate clot in the pericardium and further investigation, such as irrigation with warm saline, should be performed.

8. There is no need to close the pericardium after a negative pericardial window.

TRANS-DIAPHRAGMATIC PERICARDIAL WINDOW

1. If there is concern for intra-pericardial injury in a patient undergoing laparotomy for penetrating trauma, a trans-diaphragmatic pericardial window is rapid and highly effective in evaluating for such an injury.

2. The central tendinous portion of the diaphragm is grasped with clamps and incised vertically for 3-4cm to expose the underlying whitish fibrous pericardium. The pericardium is then grasped and sharply incised to assess the pericardial space for any gross blood. If there is none, the pericardium need not be re-approximated, although the diaphragm should be repaired with permanent suture.

MEDIAN STERNOTOMY

1. Indicated for suspected cardiac/great vessel injury based on ultrasound or positive pericardial window. In the setting of an obvious concomitant pleural space hemorrhage, anterolateral thoracotomy is preferable to sternotomy (with plans for conversion to a clamshell or trap door incision as needed to expose the heart or great vessels).

2. Does not provide for adequate exposure of left subclavian artery, distal aortic arch, or descending aorta, and provides for only limited exposure of the pleural spaces.

3. Begins with midline skin incision from sternal notch to just below xiphoid process, followed by sharp/blunt dissection both superiorly and inferiorly just deep to the sternum.

4. The sternum is divided in the midline with a sternal saw or Lebsche knife.

5. Bone wax can be used to decrease bleeding on the cut edges of the sternum, and cautery should be used to control bleeding from the sternal periosteal edges.

6. Both pleural spaces should be entered and opened widely where possible. This is facilitated by elevating the hemi-sternum, briefly holding ventilation, then opening the pleura overlying the lung with scissors or electrocautery. After the pleural space is entered, a suction device should be introduced to evacuate any blood.

7. After opening the pleural spaces, a standard chest retractor is placed. Mediastinal fat will be visible and should be divided in the midline down to the level of the fibrous pericardium. At the superior

limit of the incision, the innominate vein will be located within the mediastinal fat and care must be taken to avoid injury to this structure.

8. The pericardium is then grasped and opened sharply in the midline. A finger is then inserted into the pericardial space to allow opening the midline pericardium down to the level of the diaphragm and up to the level of the innominate vein using scissors or electrocautery. The pericardium should then be opened laterally in either direction along the diaphragm to facilitate exposure.

9. Heavy sutures should be placed in the pericardial edges on both sides then tied under tension to the skin edges or secured under tension to clamps overlying the chest wall. These sutures will minimize interference from the ventilating lungs and facilitate exposure of the heart and great vessels.

10. A sternotomy can be extended into a neck exploration incision if there is concern for carotid, jugular, or tracheal injury. For suspected proximal right subclavian vascular injury, sternotomy can be extended to a right supraclavicular incision. For suspected proximal left subclavian vascular injury, the incision can be extended into an anterolateral thoracotomy (or to a trap door incision, described below).

11. There is no indication to re-approximate the pericardium. For sternotomy closure, chest tubes are placed into the mediastinum (and into any open pleural space) and the sternum is re-approximated with a series of heavy interrupted wire sutures. Typically 3 wires are placed through each side of the manubrium, 1-2cm from the edge of the bone. For the sternal body, 3-4 additional wires are placed directly through the halves of the sternum or around the sternum through the costal interspaces. If wire is not available, large permanent suture (e.g., polyester suture, #2 or larger) is appropriate.

12. For a patient undergoing sternotomy in the setting of hemodynamic instability or ongoing massive resuscitation, temporary chest closure is advised in most cases. After placement of a laparotomy pad or wound vacuum sponge beneath the edges of both sides of the sternum to avoid laceration of the heart from movement, an occlusive adherent dressing is placed and chest tubes are placed to suction to evacuate any residual bleeding.

ANTEROLATERAL THORACOTOMY

1. Refer to JTS CPG on Emergency Resuscitative Thoracotomy.[8]

2. Useful for massive hemothorax; allows access to lung parenchyma, hilum, chest wall, and subclavian vessels.

3. For proximal left subclavian control, anterior thoracotomy in the 3rd interspace (above the 4th rib) will generally be adequate. See JTS Vascular Injury CPG.[12]

4. For general access to the pleural space, the 4th interspace is centered over the pulmonary hilum. Anterolateral thoracotomy at this level will provide access to most structures within the chest. The inframammary crease overlies the 5th rib medially in most patients, and therefore this crease provides a reasonable landmark for a 4th interspace anterolateral thoracotomy.

5. After incision of the skin and soft tissues parallel to the clavicle, from one fingerbreadth off of the sternum medially to the anterior or mid-axillary line laterally, divide the pectoralis major muscle in

the direction of its fibers, then bovie or cut the remaining fibrovascular tissues down to the top of the rib at the desired interspace.

6. Incise the intercostal muscle over the rib with electrocautery, then enter the pleural space using a blunt clamp, protect the lung, and divide the remaining muscle over the rib. Stop the intercostal incision about two finger-breadths lateral to the edge of the sternum to avoid the mammary vessels, but carry the intercostal incision as far laterally as safely possible to allow for maximal exposure.

7. Place a rib-spreader into the wound.

8. If additional exposure is needed, division of the medial costal cartilage will allow for additional rib spreading, or the incision can be extended to include a sternotomy and clavicular incision. (See description of trap door incision below.)

9. For thoracotomy closure, after the placement of chest tubes through separate stab incisions, "pericostal" sutures should be placed around the upper and lower ribs at the incision. Typically 3-5 sutures are needed, and any heavy suture (#1 or larger) may be used (although monofilament suture may have more of a tendency to dig into the intercostal muscle tissue when tied). Care must be taken to avoid the intercostal bundle with these sutures, by hugging the top of the upper rib but avoiding the bottom of the lower rib.

10. After chest tube and pericostal suture placement, the muscle is reapproximated with absorbable suture and the skin closed with staples.

CLAMSHELL INCISION (BILATERAL THORACOSTERNOTOMY)

1. Highly versatile incision, which provides adequate surgical access to virtually any structure in the thoracic cavity (with the exception of the esophagus and descending thoracic aorta).

2. Rarely appropriate as an initial incision (due to high level of incisional morbidity). Generally implemented after anterolateral thoracotomy if there is suspicion for bleeding into the contralateral pleural space, or heart or great vessel injury, or when there is inadequate exposure for an ipsilateral pleural space injury.

3. After anterolateral thoracotomy, divide the sternum transversely with a Lebsche knife, Gigli saw, or heavy shears. Both internal mammary vascular pedicles will need to be divided and controlled with ties or clips; bleeding from these may be unrecognized until adequate perfusion has been restored.

4. Create a contralateral thoracotomy (generally in the same intercostal space). Place bilateral rib spreading retractors. After initiating retraction, use scissors or cautery to release the sternum from the anterior pericardium to improve exposure.

SUPRACLAVICULAR INCISION

1. Most often indicated for suspected proximal or mid-subclavian vascular injury.

2. After an incision one fingerbreadth above and parallel to the clavicle from the midline to the distal clavicle, superficial fatty tissues, lymphatics and venous branches are divided and controlled to

expose the sternal and clavicular heads of the sternocleidomastoid muscle and the carotid sheath (located between the two muscle bellies).

3. After division of the sternocleidomastoid muscle heads just above their distal attachments, the proximal subclavian artery and its branches will be palpable and visible.

4. The anterior scalene muscle will be visible coursing anterior to the subclavian artery (posterior to the vein) and may need to be divided for adequate exposure. If this is the case, it is critical to free up and preserve the phrenic nerve, which runs directly along this muscle in a transverse direction.

5. The subclavian vein will be anterior and caudal to the artery.

6. For complex injuries, division of the clavicle (with a Gigli saw) or removal of part of the clavicle may facilitate additional exposure. Alternatively a supraclavicular incision can be combined with a separate infraclavicular exposure (for more distal subclavian access) or with a third interspace anterolateral thoracotomy (for control of the left subclavian artery at its origin).

INFRACLAVICULAR INCISION

1. If there is a known subclavian venous injury, an infraclavicular incision may provide for better exposure. This approach also provides better exposure of the more distal subclavian artery and its branches.

2. After an incision one fingerbreadth below and parallel to the clavicle from the mid-clavicular level to the lateral border of the pectoralis muscle, the pectoralis major muscle is opened transversely in the direction of its fibers.

3. The underlying clavipectoral fascia and pectoralis minor muscle are divided to expose the distal subclavian and axillary vessels. In this location, the artery will be posterior and cephalad to the vein, and the brachial plexus cords are closely associated with the artery.

TRAP DOOR INCISION

1. Combination of clavicular (or neck) incision, partial or complete median sternotomy and anterolateral thoracotomy (described above).

2. May be useful for combined penetrating cervical and mediastinal injuries or a severe injury to the proximal subclavian vessel/branches.

3. Rarely used as an initial incision due to high incisional morbidity (including risk of injuring the ipsilateral phrenic nerve, brachial plexus, thoracic duct, or other structures).

4. May be necessary for inadequate exposure after sternotomy and clavicular incisions (for right-sided injuries), or after left anterior thoracotomy and clavicular incisions (for left-sided injuries).

5. After supraclavicular incision, perform complete median sternotomy or partial median sternotomy to 4th intercostal space.

6. Incise the skin, soft tissues and muscle out to the anterior axillary line.

7. Divide the sternum laterally with sternal saw or a Lebsche knife, ligate the left internal mammary vessels, and continue the incision into the pleural space above the appropriate rib as an anterolateral thoracotomy.

THORACOABDOMINAL INCISION

1. Indicated for combined thoracic and abdominal injuries. May be particularly helpful for retrohepatic vena caval exposure.

2. May be created by continuing a resuscitative thoracotomy incision medially and inferiorly across the costal margin into the abdominal midline or by creating a separate midline abdominal incision after thoracotomy.

POSTEROLATERAL THORACOTOMY

1. Provides optimal exposure for esophagus, chest wall, descending thoracic aorta, and posterior hilum.

2. Rarely appropriate in the acute trauma setting, particularly in a multiply injured or acutely bleeding patient. This incision limits ability to treat concomitant injuries, limits anesthesia access for additional resuscitation lines, and limits ability to protect the spine. In addition, it generally requires ipsilateral lung isolation (using mainstem intubation, bronchial blocker, or double-lumen endotracheal tube), and potentially places the contralateral lung at risk for injury due to pooling of blood or secretions.

3. May be appropriate at Role 3 or higher level of care for evacuation of retained hemothorax or for addressing a complex lung injury or esophageal injury.

4. If beanbag is available, place on OR table; otherwise use large IV bags wrapped in towels placed in front of and behind the patient to secure him/her in a stable lateral position (in addition to strapping and taping the patient's hips and legs to the table).

5. Once the patient is in a secure lateral decubitus position, place a pillow between the legs, place the lower arm on an arm board straight at the elbow but flexed slightly at the shoulder, and place the higher arm in a flexed position at the elbow on a pillow or folded blankets.

6. After a wide prep and draping, mark mid-way between the medial border of the scapula and the vertebrae. Make a second mark one fingerbreadth below the inferior-most tip of the scapula. A posterolateral thoracotomy should connect these two marks in a gentle curve, then continue anteriorly parallel to the ribs.

7. After incising the skin and fatty subcutaneous tissue, divide the latissimus dorsi muscle transversely in the posterior aspect of the incision. The serratus anterior muscle, which runs anterior and deep to the latissimus, can be partially divided or mobilized and retracted anteriorly.

8. For most trauma situations, entering the chest right above the level of the tip of the scapula will provide an appropriate level for adequate exposure. After using electrocautery to divide the intercostal muscle along the top of the rib at this interspace, enter the pleural space with a blunt

clamp. Then pack the lung away with a moist laparotomy pad to allow extension of the intercostal incision widely along the top of the rib.

9. Encircling the lower rib at the posterior aspect of the incision with a right angle (taking care to avoid the intercostal bundle injury) will allow division of the rib with a rib shear to facilitate adequate retraction and exposure. However, this step is not mandatory. The creation of a "controlled fracture" by gradually opening a rib spreader will have the same desired effect of allowing adequate space to fit a hand comfortably into the pleural space.

10. Place a rib spreader.

11. For thoracotomy closure, after the placement of chest tubes through separate stab incisions, "pericostal" sutures should be placed around the upper and lower ribs at the incision. Typically 3-5 sutures are needed, and any heavy suture (#1 or larger) may be used (although monofilament suture may have more of a tendency to dig into the intercostal muscle tissue when tied). Care must be taken to avoid the intercostal bundle with these sutures, by hugging the top of the upper rib but avoiding the bottom of the lower rib.

12. After chest tube and pericostal suture placement, the muscle is reapproximated with absorbable suture and the skin closed with staples.

APPENDIX B: SPECIFIC THORACIC INJURY MANAGEMENT [19,20]

OPEN PNEUMOTHORAX

1. Treat by placing a chest tube through a separate incision and sealing the hole with an occlusive dressing. Complex chest wall defects may eventually require closure with mesh or muscle flap coverage at higher roles of care.

2. For patients with difficulty breathing, hypoxia or with large sucking chest wounds, maintain a low threshold to intubate prior to transport as positive pressure ventilation will overcome the effect of the sucking chest wound.

FLAIL CHEST

1. Generally associated with significant underlying lung contusion, which must be managed aggressively with supplemental oxygen and a low threshold for intubation and mechanical ventilation prior to air transport (or protracted ground evacuation).

2. In an awake patient with flail chest, pain control is critical to optimize pulmonary mechanics, although the use of intravenous narcotics must be balanced with the risk of respiratory depression.

3. Tube thoracostomy is appropriate prior to medical evacuation for any patient with flail chest, regardless of whether a pneumothorax or hemothorax is clinically evident.

4. There is a role for surgical stabilization of rib fractures (SSRF) in patients with flail chest or select patients with severely displaced rib fractures. SSRF should not be performed in a contaminated field, requires specialized equipment, and should only be done by surgeons familiar with the technique. For casualties undergoing further evacuation, SSRF should usually await Role 4 care. When performed, the original chest tube should be removed, the site cleaned and if possible excluded from the operative field and a new chest tube placed to reduce the risk of post-operative wound infection and osteomyelitis.

THORACIC VASCULAR INJURIES

1. The initial management of a thoracic vascular injury should be manual occlusion with a finger (for an artery) or a sponge stick (for a large vein). Temporary control can allow for additional resuscitation and exposure prior to attempted repair. For an aortic injury, a side-biting clamp may be placed (after aortic mobilization) for temporary control.

2. Repair of vessels should follow the principles detailed in the JTS CPG on Vascular Injuries, with shunting or repair by autogenous or synthetic grafts as indicated.

3. Incising the inferior pulmonary ligament mobilizes the lung to provide better exposure.

CARDIAC INJURIES

1. Isolated cardiac injuries are exposed by opening the pericardium and placing pericardial stay sutures.

2. Temporary control may be achieved with digital pressure, the use of a Foley catheter, or with skin staples.

3. For definitive repair, use pledgeted horizontal mattress sutures (2-0 or 3-0 polypropylene) on a large, tapered needle (MH or SH). Autologous pericardium can be used if commercial pledgets are not available. Sutures must be tied only to the point of hemostasis to avoid tearing potentially friable cardiac muscle. Take care to place sutures to avoid ligating coronary vessels.

4. Atrial injuries may be controlled with a side-biting clamp, followed by running closure with 2-0 or 3-0 polypropylene suture.

5. Temporary inflow occlusion (occluding the superior and inferior venae for brief intervals) may prove helpful in repair.

6. If distal coronary artery injuries are identified, they should be ligated to control the bleeding.

PARENCHYMAL LUNG INJURIES

1. Posterolateral thoracotomy is preferred for isolated lung injuries, but is only appropriate in a stable patient with adequate resuscitation and no other uncontrolled injuries. Anterolateral thoracotomy is more appropriate in the urgent or damage control setting.

2. Simple pulmonary parenchymal tears/bleeding may be repaired with absorbable suture on a tapered needle, or may be repaired with stapling of the lung parenchyma (with a GIA or TA middle-thickness staple load).

3. For deeper through-and-through injuries, a tractotomy may be performed by opening the injury tract with a GIA stapler or between straight vascular clamps, followed by running suture repair to control bleeding and air leaks from the exposed lung parenchyma.

4. For more severe/destructive lung injuries, non-anatomic partial lung resection with serial GIA stapler fires may be needed.

5. Hilar injuries or large parenchymal injuries with uncontrolled bleeding or massive air leak may require manual control of the hilum followed by hilar clamping for temporary control. Good communication with the anesthesia provider is essential to manage the resultant sudden decrease in lung volume and right heart strain. If repair is still not possible, pneumonectomy should be considered as a last resort due to the low survival associated with pneumonectomy in a trauma setting.

TRACHEOBRONCHIAL INJURIES

1. Airway control is the most important priority, and should be combined with tube thoracostomy(s). If after endotracheal intubation in a patient with a suspected airway injury, ventilation appears adequate and there is no other surgical indication, further intervention should be deferred to a higher role of care.

2. If there is difficulty with ventilation of the patient after tube thoracostomy due to a large air leak, the chest tube should be placed to water seal instead of suction.

3. When intervention is needed, median sternotomy (with cervical extension) provides exposure for the proximal and mid-trachea. Alternatively, cervical tracheal injuries can be approached from a collar incision. The distal trachea, carina, and proximal mainstem bronchi can only be visualized well via right posterolateral thoracotomy (with appropriate lung isolation). Injuries to the distal left mainstem bronchus or more distal left-sided bronchial tree generally require left thoracotomy for repair.

4. Tracheobronchial repair should employ absorbable suture (e.g., polydiaxanone or polyglactin), buttressed with pleural tissue or with intercostal or strap muscle wherever possible.

ESOPHAGEAL INJURIES

1. Most often will be identified during the course of exploration for other penetrating mediastinal injuries.

2. Although the resources for definitive repair may not be available in a deployed setting, the key principles in treatment are 1) adequate fluid resuscitation, 2) broad spectrum antibiotics, 3) debridement of any clearly non-viable tissue, 4) control of ongoing contamination, and 5) wide drainage.

3. For patients undergoing damage control procedures, chest tube drainage and a nasogastric tube placed above the level of injury are temporizing measures.

4. The preferred approach for intrathoracic esophageal injuries in a stable patient is posterolateral thoracotomy: right for the upper and mid-esophagus and left for the lower esophagus. Incising the inferior pulmonary ligament mobilizes the lung to provide better exposure.

5. Locate the injury by mobilizing the esophagus (aided by placement of a nasogastric or orogastric tube). Where possible, primary repair is preferred. After mobilizing the esophageal muscle above and below the mucosal injury to ensure complete visualization of the defect, the injury is repaired with a single layer or two layers of 3-0 absorbable sutures.

6. Buttress with muscle (intercostal or strap muscles, pericardium, diaphragm, etc.) should be used. Do not wrap the repair circumferentially. Drains should be placed near the repair.

7. If primary repair is not possible, wide drainage with proximal esophageal diversion should be considered. Resection should only be utilized in the setting of extensive tissue devitalization.

DIAPHRAGM INJURIES

1. Most often encountered at the time of abdominal exploration, all injuries of the diaphragm should be closed. If identified at the time of thoracotomy, one must evaluate for associated intra-abdominal injury. In the damage control setting, repair of diaphragm lacerations can be deferred until re-exploration.

2. The majority of injuries can be repaired with nonabsorbable running or interrupted sutures, 2-0 or larger. Mesh repair may be necessary but should be used with caution in the face of contamination.

3. Central tendon injuries of the pericardial diaphragm are rare, but when they occur they can cause tamponade physiology due to either cardiac herniation into the abdomen or herniation of the small or large intestine into the pericardium. Prior to closing central tendon tears, copiously irrigate the pericardial space with warm saline to wash out blood clots or enteric contents and carefully inspect the heart and pleural pericardium to ensure there are no other injuries or tears.[23]

CHEST WALL BLEEDING

1. Unlike bleeding from the low-pressure vascular system of the lung parenchyma, bleeding from intercostal arteries reflects systemic pressure and often will not resolve with tube thoracostomy alone.

2. Chest wall bleeding will typically be encountered after an anterolateral thoracotomy for massive or persistent chest tube bleeding. After assessing for non-chest wall bleeding sources, chest wall bleeding can almost always be temporized with manual pressure and packing. Temporary cessation of ventilation may allow for more accurate assessment and control of a chest wall bleeding site.

3. One must be cognizant of the subclavian vessels, which are closely associated with the anteroapical chest wall. If significant chest wall bleeding appears to be arising from this location, additional supra- or infraclavicular incisional exposure may be needed.

4. Once a direct site of chest wall bleeding is identified, it can be controlled with clips, suture, or cautery. Placing figure-of-eight pericostal sutures using a large, blunt needle (CT or MH) around the involved rib (proximal and distal to the bleeding site) may be effective.

5. Adequate visualization may require enlarging an incision, or making a separate counter-incision to improve the angle of approach.

6. In an unstable patient, chest wall bleeding can be temporized with packing using gauze or hemostatic adjuncts.

CONCOMITANT INJURIES

1. As described above, the management of patients with suspected combined thoracic and abdominal penetrating injury depends on initial stability.

2. In the face of hemodynamic collapse or loss of vital signs, emergency resuscitative thoracotomy is indicated for temporary control of thoracic bleeding, assessment for intra-pericardial bleeding, control of the descending thoracic aorta, and open cardiac massage.

3. In unstable patients with combined thoracic and abdominal injuries, or when CT scan is not available, midline laparotomy with tube thoracostomy (unilateral or bilateral, depending on injury pattern) and trans-diaphragmatic pericardial window is a safe approach.

4. For patients with combined injuries of the neck and chest, a cervical incision can easily be extended into a median sternotomy (for cardiac or great vessel injury or for proximal control of the right subclavian or either carotid artery), or into right or left supra- or infraclavicular incisions (for subclavian vascular injuries). In addition, a separate anterior or anterolateral thoracotomy may be indicated based on tube thoracostomy output or the need for proximal control of the left subclavian artery.

TRANS-MEDIASTINAL WOUNDS

1. Penetrating wounds which traverse the mediastinum via one or both pleural spaces represent a highly complex injury pattern, and every intra-thoracic structure is at risk. Intra-cardiac injuries (valve or septal injury) should also be suspected with this pattern of injury.

2. At the Role 2 level, care for suspected trans-mediastinal injury (after ensuring adequate airway and intravenous/intra-osseous access) should consist of bilateral tube thoracostomy and assessment for intrapericardial bleeding. Following the algorithms outlined above, surgical intervention may be appropriate. For unstable patients with suspected trans-mediastinal penetrating injury, a left anterior thoracotomy with right chest tube should be performed, with conversion to clamshell incision when needed to address intrapericardial or right chest bleeding.

3. At the Role 3 level with a hemodynamically stable patient, CT imaging should be performed to better estimate the missile trajectory(s), allowing a determination of structures at high risk for injury (keeping in mind that high-velocity weapons can inflict significant destruction outside the direct missile path). Using intravenous contrast with the CT allows assessment for vascular injuries without the need for invasive diagnostic angiography. Where available, esophagoscopy and bronchoscopy may be indicated if there is clinical or radiographic evidence of esophageal or tracheobronchial injury, respectively. Echocardiography can be utilized to assess for cardiac valvular injuries or septal defects. Definitive repair of these injuries can usually be delayed and should await Role 4 where the appropriate expertise and support is available.

RETAINED HEMOTHORAX

1. Retained hemothorax is defined as undrained blood after 72 hours of tube thoracostomy drainage. Except under extenuating circumstances (such as protracted delay for medical evacuation), the treatment of retained hemothorax should be deferred to Role 3 or higher where CT imaging is available.

2. If a retained hemothorax is suspected by a chest X-ray, CT imaging should be obtained. If the volume of undrained blood is estimated at greater than 300cc and if it is felt to be clinically significant, then additional drainage intervention should be considered.[24]

3. Additional drainage procedures may consist of an additional tube thoracostomy (low yield after 24 hours), video assisted thoracoscopic surgery (VATS) drainage, image-guided drainage catheters or instillation of intrapleural thrombolytics. None of these approaches has demonstrated clear superiority.[25] Thoracotomy may be required if less invasive interventions fail.

4. The intra-pleural administration of thrombolytics is an established but unproven adjunct to chest tube drainage for retained traumatic hemothorax. In the absence of active bleeding or other typical contraindications to thrombolytic therapy and in the absence of an ongoing air leak (which would contraindicate a period of clamping the chest tube), 50mg of altepase (tPA) in 100ml of normal saline may be administered into the pleural space via chest tube utilizing sterile technique. The chest tube should be clamped for several hours, then placed back on suction. This treatment can be repeated daily for up to three days. tPA will generally be available in a 1mg/ml concentration, such that the 50mg/50ml dose of tPA should be combined 1:1 with 50ml of sterile saline.

APPENDIX C: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Whole Blood Transfusion (CPG ID: 21)

This CPG provides the rationale and guidelines for WB transfusion, including but not limited to product definitions, indications, collection, storage, testing, transfusion, and documentation.

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DEFINITIONS

Whole blood (WB) collected in the anticoagulants CPD or CPDA-1 is an FDA-approved product when it is appropriately collected, stored and tested for transfusion transmitted disease (TTD) by a licensed blood donor center. It can be stored for 21 days at 1-6°C in CPD or 35 days at 1-6°C in CPDA-1 and is designated stored whole blood (SWB) in this CPG. SWB retains in vitro hemostatic parameters to an acceptable level during approved storage duration.[1] However, after the first 2 weeks of storage, the hemostatic function of WB may vary and supplementation with fresher whole blood units or blood components, especially platelets, may be necessary.

Fresh whole blood (FWB) refers to WB collected on an emergency basis from a "walking blood bank" (WBB). FWB can either be stored at room temperature and used within 24 hours of collection (and then destroyed if not used) or it can be refrigerated within 8 hours of collection, after which point it becomes WBB-SWB. FWB is considered to have full hemostatic function. FWB is collected from pre-screened donors when possible, but does not undergo TTD testing prior to transfusion; this fact makes it not approvable by the FDA. Because FWB presents a higher risk of disease transmission, it is reserved for situations in which tested blood products are unavailable or ineffective (further discussion below).

The most important safety consideration in transfusing WB is that donor red blood cells (RBCs) be compatible with the recipient to avoid acute hemolytic transfusion reactions (a.k.a., major mismatch). WB from group O donors contains RBCs that are compatible with all recipients, but the plasma in group O WB may contain anti-A and anti-B antibodies that could cause hemolysis in a non-group O recipient (a.k.a., minor mismatch). There are two approaches to mitigating this risk: 1) transfuse only group-specific WB (i.e. A to A, B to B, AB to AB and O to O), or 2) anti-A and anti-B antibody titers can be measured in group O WB and only units containing a low titer of antibody (e.g., <1:256 saline dilution, immediate spin method) are designated "low titer O WB" (LTOWB) and these are used as "universal WB." LTOWB has been used extensively to resuscitate combat casualties and was a standard of care in WWII, and the conflicts in Korea and Vietnam.[2] Note that LTOWB may be either SWB or may be collected from pre-screened O donors in a WBB protocol and thus be considered FWB (e.g., the Ranger O Low titer or ROLO protocol).[3] In practice, the only SWB supplied by the Armed Services Blood Program (ASBP) to OCONUS locations will be LTOWB due to the relatively higher risk of donor-recipient blood group mismatch and resulting hemolysis during group-specific WB transfusion, compared to the much lower risk of hemolysis with LTOWB.[2] Collecting LTOWB from WBB pre-screened donors is also preferred to group-specific transfusion. In short, most WB transfused during future contingency operations will be LTOWB, and most of this is likely to be SWB. Use of LTOWB is recognized under AABB Standard 5.15.1 (31st Edition, AABB Standards, in effect beginning 01 April 2018).[4]

It should be noted that anti-A and anti-B titers may vary in group O donors. Ideally, WBB donors should be re-titered every 90 days in conjunction with TTD testing. However; since availability of titer testing in the deployed setting is very limited, every effort should be made to ensure that donors are titered at least annually if not prior to each deployment. ASBP collects WB from male and never-pregnant female donors, or from female donors testing negative for anti-HLA antibodies (this mitigates risk of transfusion-associated acute lung injury, TRALI). WB is primarily collected from Rh positive donors and there is a limited supply of Rh negative blood products in the deployed environment. Every effort should be made to provide Rh negative whole blood or red cells to females of child-bearing potential (age<50 years) who are Rh negative or of unknown blood type. However; should transfusions of Rh positive blood products occur in these patients, these must be thoroughly documented in the patient's medical record due to the risk of allo-immunization to Rh and potential for hemolytic disease of the fetus/newborn (HDFN) in future pregnancies.

All WB products (SWB, FWB, and LTOWB) are indicated for the resuscitation of massive blood loss. WB, and in particular LTOWB, is the preferred resuscitation product for the pre-hospital treatment of patients in hemorrhagic shock.[5,6] This CPG will distinguish between stored whole blood (SWB) and fresh whole blood (FWB), and discuss uses and limitations of both products.

BACKGROUND

The first documented animal-to-animal (dog) blood transfusion was performed at Oxford in 1665 by Richard Lower, followed by the first animal-to-human blood transfusion in 1667 by Jean Denis. The first human-to-human blood transfusion was performed by James Blundell in 1818. In the year 1900, the ABO blood grouping system was classified by Landsteiner and, based on this, the first pre-transfusion cross-match was done by Ottenberg in 1907. The system of Rh typing was invented by Landsteiner and Wiener in the year 1940.[7] In military settings, whole blood has been used extensively to resuscitate casualties in military conflicts since 1917, during World War I.[8] Whole blood is the starting point for blood donation and continues to be used extensively worldwide where component production is not available.

Blood safety and sustainability are global issues. Component development supports the sustainability of blood services where demand can outstrip supply. Component use also permits optimal storage conditions for each element of the blood, minimizes hemolytic reactions and supports precision treatment. Examples include the use of red blood cells (RBCs) for anemia, fresh frozen plasma (FFP) to replace lost or consumed clotting factors, platelets (PLTs) for platelet abnormalities and thrombocytopenia, and cryoprecipitate (Cryo) for hyperfibrinogenemia. Whole blood contains all of these elements in a smaller volume of anticoagulant and thus provides a more concentrated product for treating bleeding patients who need all elements of blood replaced. The widespread use of component therapy is driven by blood product availability. For the reasons outlined above, blood banks have preferred to stock components over WB.

The clinical data comparing WB to components have recently been reviewed.[6] Currently available clinical data indicate that use of WB to treat hemorrhage results in outcomes that are at least as favorable as those that can be expected with component therapy that includes RBCs, plasma and platelets.

Severely injured combat casualties requiring transfusion have a significant mortality rate (16%) and have the greatest potential to benefit from early and appropriate transfusion strategies. A large retrospective cohort study of casualties requiring transfusions during Operations Iraqi Freedom (OIF) and Enduring Freedom (OEF) suggests a significant survival benefit for transfused casualties when RBCs, fresh frozen plasma, and platelets are transfused at a 1:1:1 ratio.[9] A recent randomized trial in civilian trauma patients demonstrated that a 1:1:1 transfusion ratio resulted in improved early hemostasis, though no statistically significant improvement in survival.[10] Two retrospective analyses in combat casualties comparing FWB to component therapy (which included platelets) have also been published. One study showed a potential survival benefit to the use of FWB during resuscitation of severe combat injuries, and the other showed FWB to be equivalent to component therapy.[11,12] These studies underscore the importance of providing all elements of whole blood (RBCs, plasma and platelets) to severely bleeding patients and suggest that use of either WB or components in a 1:1:1 ratio for resuscitation of bleeding patients is acceptable; product choices can be guided by practical considerations.

ADVANTAGES OF WHOLE BLOOD OVER COMPONENTS

SWB and FWB provide FFP:RBC:PLTs in a physiologic ratio and return to the bleeding patient what has been lost. It should be noted that the 1:1:1 ratio of blood components (platelets: plasma:RBC) recommended for damage control resuscitation does not faithfully reconstitute WB. The 1:1:1 ratio yields a dilute blood mixture with a hematocrit of 29%,[13] a platelet count of approximately 90,000/µL, and coagulation factors diluted to approximately 62% of WB concentrations due to the presence of anticoagulants and red cell additive solution. In addition, WB delivers all needed elements of blood in only one product, which only requires refrigeration for storage. In contrast, component therapy requires multiple products and storage modalities (refrigeration, freezing and generally room temperature storage with agitation for platelets – though platelets can also be refrigerated), greatly increasing workload and complexity for clinical teams.

SWB collected in licensed blood centers offers the same level of TTD safety as component therapy collected in licensed centers. It should be noted that due to the extremely short shelf life of standard room temperature stored platelets (5 days), all platelet products transfused in the deployed setting are collected in theater and do not undergo TTD testing prior to transfusion. Therefore, SWB collected in licensed centers and fully tested presents a lower TTD risk than component therapy using in-theater collected platelets or FWB.

For U.S. casualties presenting in hemorrhagic shock, a transfusion strategy that included FWB with RBCs and plasma was associated with an improved survival compared to the use of stored components only (FFP, RBCs, and PLTs).[11] Compared to SWB or component therapy, FWB is more readily available in austere conditions and requires only the presence of donors and simple collection equipment, though safe collection and transfusion of FWB requires appropriate pre-deployment training [14,15] and careful donor evaluation. FWB has no loss of the labile clotting factors or platelet activity that is often associated with storage, has close to physiological hematocrit and has no red blood cell "storage lesion." Storage lesion describes the degradation of the RBC involving loss of membrane plasticity,[11,12] diphosphoglycerate, adenosine triphosphate, nitric oxide, and other factors leading to potentially reduced delivery of oxygen to tissues and contribution to a variety of pathophysiologic processes.[16] It should be noted that recent randomized trials assessing the effects of red blood cell storage age have not confirmed a clinically detectable deleterious effect of the red cell storage lesion in the populations evaluated. The effect of red cell storage age, whether in component therapy or SWB has not been rigorously evaluated in certain vulnerable populations, such as trauma patients.[17]

Overall, both SWB and FWB offer at least comparable performance and safety compared with components, as well as compelling logistical advantages that are particularly important in pre-hospital resuscitation and indeed, in most deployment settings.

CONSIDERATIONS IN CHOOSING SWB OR FWB

There are risks associated with the use of FWB, including but not limited to increased risk of transfusion-transmitted infections (e.g., HIV, hepatitis B/C, syphilis), and an increased risk of clerical errors leading to major mismatch when ABO-identical WB is provided, due to the potentially chaotic conditions during which FWB is requested. Additionally, field conditions are inherently unsanitary and are presumed to increase the risk of bacterial contamination of the blood. Recent history with approximately 10,000 FWB transfusions to U.S. personnel during OIF/OEF have resulted in one Hepatitis C (HCV), one Human T-Lymphocyte Virus (HTLV) seroconversion, and one fatal case of transfusion-associated graft-versus host disease that was potentially due to a FWB transfusion.[4] FWB is not FDA-approved and is not intended or indicated for routine use. It is NOT appropriate, as a matter of convenience, to use FWB as an alternative to more stringently controlled blood products for patients who do not have severe, immediately life-threatening injuries. FWB is to be used only when other blood products cannot be delivered at an acceptable rate to sustain the resuscitation of an actively bleeding patient, when specific stored products are not available (e.g., SWB, RBCs, FFP, PLTs, Cryo), or when stored components are not adequately resuscitating a patient with an immediately life-threatening injury. FWB should not routinely be collected from pre-screened donors as a way to maintain a routine inventory of WBB-SWB products. In other words, the use of WBB for collection of FWB is for emergency use only. It should be noted that studies of FWB donors have not documented significant decrements in military-relevant task performance following donation. Thus, concerns that FWB collections will adversely affect mission outcomes have not been substantiated and should not preclude WBB activation when conditions for FWB use are met.[18]

In patients receiving LTOWB (SWB or FWB), every effort should be made to obtain a pre-transfusion blood sample in order to establish the original blood group. If blood samples are obtained after transfusion with LTOWB, it may be impossible to definitively establish a patient's blood group with the equipment available in the deployed setting. As a result, patients of unknown blood group receiving LTOWB will continue to receive LTOWB or group O RBC units for their acute transfusion requirements for up to a month following admission. This can deplete inventories of LTOWB and group O RBCs.

WHOLE BLOOD RECOMMENDATIONS

- SWB, which will in practice be LTOWB, is the preferred product for pre-hospital resuscitation.
- In a facility capable of providing surgical care (Role 2 or higher), SWB (in practice, LTOWB) or component therapy (including RBCs, plasma and platelets) can used for damage control resuscitation. SWB simplifies transfusion and may facilitate more rapid resuscitation of casualties, and may enhance a facility's capacity to manage MASCAL challenges.
- The use of FWB should be reserved for casualties with clinically significant shock or coagulopathy (e.g. bleeding with associated metabolic acidosis, thrombocytopenia or INR>1.5) and when SWB or optimal component therapy (e.g., apheresis platelets and FFP) are unavailable, or when stored component therapy is not adequately resuscitating a patient with immediately life-threatening injuries.

GUIDELINES FOR WALKING BLOOD BANK PROGRAM FOR FWB

The decision to use FWB is a medical decision that must be made by a physician who has full knowledge of both the clinical situation and the availability of compatible blood products. A Walking Blood Bank (WBB) Program should be established based on a risk assessment and the potential for casualties. The calculation of risk should include a medical intelligence assessment which includes infection prevalence and the need for preventative force protection measures. In practice, all forward-deployed MTFs should establish a WBB. Coordination with the Area Joint Blood Program Officer (AJBPO) is required to establish a WBB Program. (Appendix B: Blood Donor Pre-screening Standard Operating Procedure [SOP]). FWB should be collected for transfusion as outlined in Appendix C: Emergency Whole Blood Drive SOP. In general, the use of FWB should be limited to casualties who are anticipated to require a transfusion when the physician determines that SWB or optimal component therapy is unavailable or in limited supply, or in patients that are not responding to SWB or component therapy. The decision to initiate a FWB drive should be made in consultation with the appropriate MTF medical authority (e.g., Deputy Commander for Clinical Services (DCCS), Trauma Director, Trauma Surgeon) and Laboratory/Blood Bank OIC. At Role 2 facilities, the lead surgeons and/or facility OIC should be consulted on the decision to initiate the drive.

Pre-screened donors registered into the WBB Program are preferably composed of active duty, active reserve, active National Guard, and other DoD beneficiaries. The preferred donors for FWB are fully pre-screened, low titer O donors. Next, consider fully pre-screened donors of other blood groups for group-specific transfusions (e.g., A to A). Donors who have not been pre-screened for TTDs should be considered only when no other donors are available. Note that in chaotic circumstances such as tactical care under fire or mass casualty (MASCAL) scenarios, or if blood grouping equipment is not available in adequate quantities, use of group O FWB of unknown anti-A and anti-B titer may be safer than attempting to match blood groups between donors and recipients, since the risk of hemolysis from major mismatch is greater than the risk of transfusing a very high titer group O unit (very high titers units being relatively uncommon) to a non-group O recipient. Indeed, this strategy was successfully employed by a Forward Surgical Team in Afghanistan.[19]

Donors should be screened to international mandated and national standards. Coalition Forces will not be utilized routinely as donors, due to national variances in screening for blood borne diseases and differences in disease prevalence. Blood may be collected from pre-screened coalition partner forces if the screening program has been reviewed by the JBPO and deemed acceptable by the COCOM Surgeon and the ASBP Director. Planned coalition activity should address the interoperability of donor panels. Non-Coalition Force foreign nationals should be used as a last resort.

The decision to use FWB that has not been completely screened for infectious agents is a medical decision that must be made after thorough consideration of risks and benefits. Decision-making should be adequately documented in the casualty record.

The blood type on identification tags is occasionally incorrect (last correlated data equated to about 4% inaccurate) [20-22] and must not be relied upon routinely to determine blood type for either donors or recipients. Identification tags for ABO/Rh verification should be utilized as a last resort only.

Use of non-standard blood donation material and equipment may lead to coagulation during the collection process potentially causing an adverse transfusion reaction; therefore, only authorized equipment will be utilized (Appendix C enclosure: WBB Supply List [with NSNs]).

Prior to issuing FWB for transfusion, the ABO and Rh type should be verified and approved rapid infection disease tests (e.g., HIV, HCV, and HBV) should be performed as outlined in Appendix C: Emergency Whole Blood Drive SOP to the greatest extent possible.

Theater Medical Data Stores (TMDS), Blood Portal, shall be utilized to record FWB donations and infectious disease testing results.

Frequency of FWB donation must be tracked. In general, WB units should not be collected from donors more frequently than every 8 weeks (56 days). This interval between donations is important to allow the donor to recover RBC mass and iron stores and should not be shortened except under the most extreme circumstances. Donors who give blood frequently may develop iron deficiency even in the absence of anemia. Iron deficiency can cause fatigue, difficulty concentrating, pica, restless leg syndrome (RLS), and eventually anemia if untreated. Iron deficiency can be diagnosed by measuring serum ferritin levels (deficiency defined as ferritin <30 mcg/L in males and <20 mcg/L in females). In deployed settings, it may be impossible to measure ferritin levels but donors at particular risk of iron deficiency include: young donors (to early 20's), premenopausal females, frequent donors (males ≥ 3x/year, females ≥ 2x/year), and donors near hemoglobin cutoff for donation (males 13.0 g/dL, females 12.5 g/dL). Consideration should be given to screening ferritin prior to deployment in high risk donors, particularly low titer O donors who may be called upon to donate more frequently. Consideration should be given to empiric iron supplementation in high risk donors or donors with symptoms of iron deficiency (available as ferrous sulfate 325mg (65mg elemental iron), ferrous gluconate 325 mg (38mg elemental iron), or multivitamins with iron (18-19 mg elemental iron); one tablet per day for 60-120 days may be adequate to replete iron stores).[23,24] Patients with documented iron deficiency (low ferritin levels as above) should be offered iron supplementation and monitored for response.

WBB PLANNING

Since the need for FWB cannot be predicted, a robust contingency operational plan should be developed by the MTF staff to include the Laboratory/Blood Bank and surgical and anesthesia providers in coordination with the Area Joint Blood Program Officer. The plan should be reviewed and rehearsed regularly. Equipment and consumables should be inspected with due attention paid to storage conditions and expiry dates.

The key elements for planning and readiness to administer FWB are knowledge and rehearsal of two SOPs: Blood Donor Pre-Screening (Appendix B) and Emergency Whole Blood Drive (Appendix C).

- A contingency plan should be developed for collecting, storing, and transfusing FWB in MASCAL situations or when it may be deemed that the current blood inventory will be exhausted prior to re-supply (e.g., when multiple type-O trauma casualties are exhausting the type-O RBC inventory).
- The physical donation site should be organized in such a way as to maintain the integrity of the screening and donation process, and to minimize the possibility of clerical errors. This is especially important in emergency situations involving more than one casualty.
- Every effort should be made to adhere to the same screening, drawing, labeling, and issuing standards required for U.S. FDA-approved blood products.

- Pre-screened donors in the WBB Program determined to be suitable should be utilized, to the greatest extent possible, before using personnel who: (1) have been pre-screened or donated in the past but do not have current (within 90 days) screening and infectious disease testing; (2) have no pre-screen or donation history. All donors must be rescreened at the time of donation.
- Use LTOWB donors if available. Otherwise, upon determining the ABO/Rh status of the casualty, activate the WBB Program, re-calling pre-screened donors with the same ABO/Rh using the TMDS>Manage Donor>View Donor List, if available, or other record keeping systems. All donors should have their ABO/Rh verified (i.e. Eldon card or laboratory testing) at the time of donation. Titers for LTOWB donors should be obtained pre-deployment, which should be no more than 12 months prior to donation. The ABO and RhD group should be the same as that on the dog tag and records. Before any FWB is transfused, rapid infectious disease testing (i.e. HIV, HBV, HCV) of donor specimens shall be performed, to the greatest extent possible.
- Retrospective samples must be sent to a licensed laboratory for FDA-approved testing, regardless of whether the rapid infectious disease testing is performed pre- or post-transfusion, as these tests are not licensed for donor testing.
- Upon the notification of confirmed positive infectious disease results, a medical provider or preventive medicine personnel will be notified to ensure that the donor is notified and counseled. Donors and unit commanders must understand the importance of donor tracing.
- If a patient receives a confirmed positive infectious disease unit, the AJBPO will notify the Armed Services Blood Program immediately to initiate patient notification and an evaluation of both the donor and patient.
- In accordance with HA Policy 10-002, Policy on the Use of Non-U.S. Food and Drug Administration, recipients of FWB shall receive follow-up advice and infectious disease testing as soon as possible, and at 3-, 6-, and 12-months post-transfusion.
- Procedure. See Appendix B enclosure: ASBP 572–EWB (Emergency Whole Blood).
- Only one unit of FWB should be collected per donor. In situations where there are a limited number of donors and a dire need for blood, no more than two units may be taken from a donor. Performance decrements may occur after two-unit collections and volume resuscitation of the donor may be necessary. Collection of more than one unit per donor should only be considered under extreme circumstances and these should be thoroughly documented.

WB PEDIATRIC CONSIDERATIONS

WB has been administered to pediatric patients in recent conflicts.[25] WB has not been rigorously studied in pediatric trauma resuscitation, but has been shown to reduce blood loss and transfusion requirements in pediatric cardiac surgery.[11]

There are no established clinical criteria for administration of WB in bleeding pediatric patients. Physiologic variables should be interpreted by age (e.g. hypotension = systolic blood pressure < 70 + 2*age in years).

For patients <40kg, WB should be delivered in “unit doses” of 10-15 ml/kg. WB is more readily volume-titrated than component therapy. There are no known contraindications to using WB in pediatric casualties.

A massive transfusion in children is defined as 40 ml/kg (total blood volume is approx. 70-80ml/kg).[25]

PERFORMANCE IMPROVEMENT (PI) MONITORING

POPULATION OF INTEREST

1. All patients who receive blood product transfusion within 3 hours of injury
2. All patients who meet criteria for blood transfusion (severe traumatic injury (ISS ≥16 and ≥ 2 body regions injured with AIS severity ≥ 2 AND SBP < 100 OR HR > 100 OR hematocrit < 32% OR pH <7.25 within 3 hours of injury)

INTENT (EXPECTED OUTCOMES)

1. LTOWB is used for prehospital resuscitation of casualties with life-threatening injuries and hemodynamic instability (HR > 100 or SBP < 100).
2. For the population of interest, the first resuscitation fluid given after injury is a blood product, ideally cold-stored LTOWB.

PERFORMANCE / ADHERENCE METRICS

1. The number and percentage of patients in the population of interest who receive WB transfusion prior to arrival at first role of care.
2. Number and percentage of patients in population of interest who received a blood product as the first resuscitation fluid.
3. Number and percentage of patients in population of interest who received cold-stored LTOWB as the first resuscitation fluid.

DATA SOURCE

- Patient Record
- DoD Trauma Registry
- Blood transfusion databases

SYSTEM REPORTING & FREQUENCY

The above constitutes the minimum criteria for PI monitoring of this CPG. System reporting will be performed annually; additional PI monitoring and system reporting may be performed as needed.

The system review and data analysis will be performed by the JTS Chief and JTS PI Branch.

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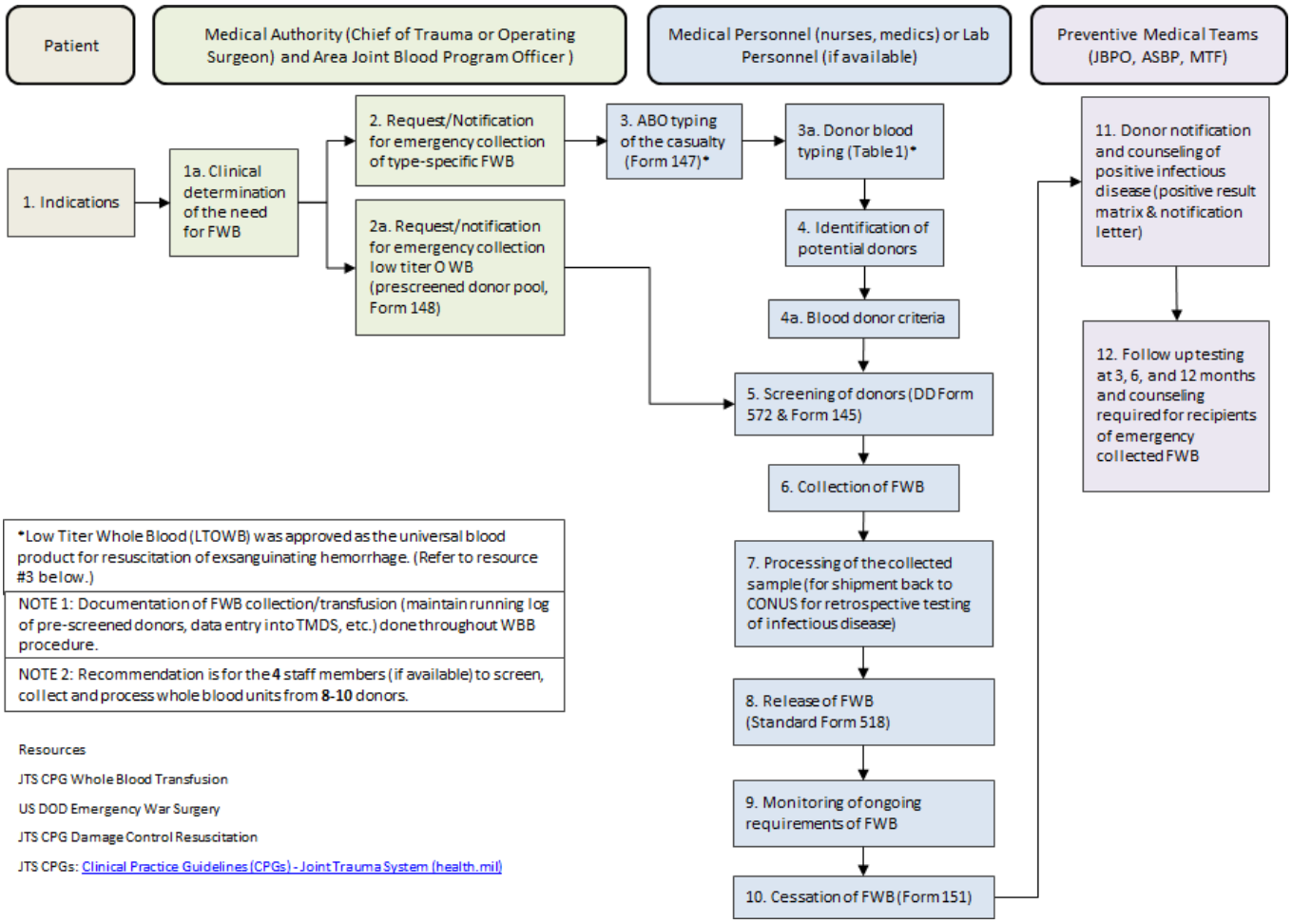
APPENDIX A: WALKING BLOOD BANK PROCESS MAP


Patient
Medical Authority (Chief of Trauma or Operating Surgeon) and Area Joint Blood Program Officer)
Medical Personnel (nurses, medics) or Lab Personnel (if available)
Preventive Medical Teams (JBPO, ASBP, MTF)
1. Indications
1a. Clinical determination of the need for FWB
2. Request/Notification for emergency collection of type-specific FWB
2a. Request/notification for emergency collection low titer O WB (prescreened donor pool, Form 148)
3. ABO typing of the casualty (Form 147)*
3a. Donor blood typing (Table 1)*
4. Identification of potential donors
4a. Blood donor criteria
5. Screening of donors (DD Form 572 & Form 145)
6. Collection of FWB
7. Processing of the collected sample (for shipment back to CONUS for retrospective testing of infectious disease)
8. Release of FWB (Standard Form 518)
9. Monitoring of ongoing requirements of FWB
10. Cessation of FWB (Form 151)
11. Donor notification and counseling of positive infectious disease (positive result matrix & notification letter)
12. Follow up testing at 3, 6, and 12 months and counseling required for recipients of emergency collected FWB
*Low Titer Whole Blood (LTOWB) was approved as the universal blood product for resuscitation of exsanguinating hemorrhage. (Refer to resource #3 below.)
NOTE 1: Documentation of FWB collection/transfusion (maintain running log of pre-screened donors, data entry into TMDS, etc.) done throughout WBB procedure.
NOTE 2: Recommendation is for the 4 staff members (if available) to screen, collect and process whole blood units from 8-10 donors.
Resources
JTS CPG Whole Blood Transfusion
US DOD Emergency War Surgery
JTS CPG Damage Control Resuscitation
JTS CPGs: Clinical Practice Guidelines (CPGs) - Joint Trauma System (health.mil)

APPENDIX B: BLOOD DONOR PRE-SCREENING SOP

Blood Donor Pre-Screening Standard Operating Procedures

This Standard Operating Procedure (SOP) accompanies the Whole Blood Transfusion Clinical Practice Guideline published by the Joint Trauma System, the DoD Center of Excellence for Trauma.

1.0 Material and Equipment

Use the following:

- ASBP 572- Emergency Whole Blood (EWB)
- Clip Boards
- Gloves
- Testing Collection Set: premade bags with 2x2 gauze, 2 red top tubes, 4 purple top tubes,
  Note: More tubes may be required if using short draw or small volume tubes
  Note: Gold/yellow top (serum separator) tubes may be substituted for red top tubes.
  Note: Pearl top (plasma preparation) tubes may be substituted for 3 of the purple top tubes.
- Blood Collection Needles
- BD Vacutainer Hubs
- Coban
- Assigned Pre Screen ISBT Labels (500 number series)
- Sharps Containers
- ABO/Rh Testing Card (e.g., Eldon Military Kit or other FDA-approved device)
- Centrifuge
- Disposable Pipettes
- Plastic Aliquot tubes/lids 13X100mm (or 12X75mm)
- Para-Film
- Biohazard Bags
- Trash Bags
- Leak Resistant Chucks
- Disposable Lab Coats
- Cold Packs
- Test Tube Racks

2.0 Records/Forms

- ASBP 572-EWB, Form 147, Form 148
- Theater Medial Data Store (TMDS), Blood Portal

3.0 Quality Control

- If possible, perform quality check on ABO/Rh Testing Card (See package inserts for procedures).
- Medical personnel should be trained by blood donor center/Blood Support Detachment or other qualified personnel.

4.0 Procedure

Pre-screening of a prospective emergency whole blood donor pool is mandatory. Development of a pre-screened donor pool should be considered a commander's priority when preparing for deployment and/or after arrival into theater. It is imperative that a donor pool once established is maintained because of the frequent redeployment of units out of theater and change of assigned personnel. Due diligence in establishing a pre-screened whole blood donor pool will decrease the risk of transmitting infectious disease while simultaneously increasing the efficiency of the whole blood collection process.

1

Perform the following steps when pre-screening donors:

1. Prepare for donor pre-screening event

Coordinate with appropriate units/contacts for times and location of event. May need to conduct a site survey to ensure appropriate site (i.e. space, lighting, privacy for interview). Samples need to be sent to the testing lab/donor center/blood support detachment as soon as possible after collection, so prior coordination with transport assets is a must.

2. Conduct the pre-screening event

- **Medical history**: Provide prospective donor an ASBP 572-EWB– ensure demographic info is legible and as complete as possible.
- **Interview**: Trained medical personnel will need to determine if the donor is eligible to donate based on the information collected.

  ***NOTE**: ONLY GROUP A questions (1-8) on the ASBP 572-EWB must be completed by the donor for pre-screening.*

- If/Then Scenarios
  a. **If:** Response to question 1 is "Yes" AND Responses for questions 2-8 are "No"
  Then: Document acceptability of Group A question responses on ASBP 572-EWB and proceed to step 3

  b. **If:** There are any "Yes" responses for questions 2-8 AND/OR Response to question 1 is "No"
  Then: Document the reason for the "Yes" response (questions 2-8) or "No" response to question 1. Defer the donor and document unacceptability of Group A question responses on ASBP 572-EWB.

3. Phlebotomy

a. Collect 4 Purple Top and 2 Red Top tubes and label with small Pre-Screen (500 number series will be used in theater) ISBT labels (without barcodes).

b. Apply the same ISBT label number to the ASBP 572-EWB. If no ISBT labels available, label tubes with donor's full name and DoD ID.

4. Register donor in TMDS per Manage Donations/Donors
See steps below in section 5.0 Maintain Database (TDMS)

***Note**: **Rapid Infectious Disease Testing is not required for the pre-screen of donors.** If performed, see Emergency Whole Blood Collection SOP for instructions.*

5. Perform ABO/Rh Testing

a. Utilizing blood from purple top tube, perform ABO/Rh confirmation using Eldon Card or other FDA-approved method to verify ABO listed on ASBP 572-EWB. (Refer to package inserts and approved facility/unit SOPs for further instructions).

b. Record Lot # of reagents, EXP Date and Results on Form 147.

c. Record blood type in TMDS.

6. Process Samples for Shipment & Testing

a. Centrifuge 2 Red Top and 3 Purple Top Tubes for 5 minutes at 4000 RPM.

b. Label three aliquot (pour off) tubes with corresponding ISBT Labels with small barcodes. Position the ISBT label vertically toward top of tube as shown at left. Write "Serum" on one tube and "Plasma" on the other two tubes. If ISBT labels are not available utilize the Donor's DoD ID or other unique identifier as appropriate to label the pour off tubes.

c. Place plasma from 3 Purple Top tubes into the 2 aliquot tubes labeled "Plasma". *3ml sample requirement per aliquot.

d. Place serum from 2 Red Top tubes into the 1 aliquot tube marked as "Serum". Do not fill over ¾ full to allow for expansion from freezing

e. The seal of capped aliquot tubes should be reinforced with para-film wrap and placed into a biohazard shipping bag or rack. If a rack is not used, rubber-band tubes from the same donor together. Repeat for each series.

f. Record sample and donor demographic data on Form 148 (Shipping Manifest). Include a printed copy of manifest with shipment and e-mail to donor center, BSD or designated facility, if possible.

g. Maintain the (pre-screening) ASBP 572-EWB at your site until the potential donor redeploys. As soon as possible ship samples and Form 148 in a blood box (Collins Blood Box) with ice bag(s) to your respective blood detachment or designated receiving facility. E-mail a copy of manifest to BSD or designated facility, if possible, and call to alert about incoming shipment.

***NOTE*: *Samples may be** *frozen until they can be shipped to a designated laboratory to perform FDA-approved testing. Contact COCOM Joint Blood Program Office (JBPO) for guidance on specimen acceptability requirements.*

***NOTE:** *Depending on pre-screening unit location and prior coordination, it may be possible to ship specimens directly to a testing or processing facility without performing the tube centrifugation and sample pour offs. Prior coordination MUST be made with COCOM JBPO or testing facility to ensure samples will remain viable if centrifugation step above will be skipped.* All donor tubes MUST be centrifuged and serum/plasma removed from RBCs within 72 hours of collection.

h. The BSD or designated unit/facility will send all samples to designated laboratory for FDA-approved testing. BSD or designated facility will enter results in TMDS and forward to submitting Role 2 or Role 3 upon completion. In some cases, the submitting Role 2 or Role 3 may have to enter results into TMDS if not supported by a BSD.

***NOTE**: The prospective donor is NOT considered pre-screened and fully qualified for FWB donation until negative or non-reactive testing results are received from a testing facility. Once confirmatory testing is received back from the testing facility and results entered into TMDS, the donors are prescreened and eligible for donation and can be verified utilizing TMDS.*

NOTE: *Testing for type O donors may include anti-A and anti-B titer testing. The titer testing must be coordinated with the testing facility prior to sample shipment. Donor should not be used as a universal type O whole blood donor until titer results verify low titer status.*

i. Any positive testing that is received by BSD or unit will be forwarded to Preventive Medicine Consultant or available Provider (MD, DO, PA, NP) to ensure proper donor care and follow-up is initiated. At no time will laboratory staff notify donors directly regarding positive testing results.

5.0 Maintain Database (TMDS)

1. Transfer demographic information from the modified ASBP 572-EWB and Form 147 to Donor Management Database in TMDS. This will act as a deferral list or an eligible donor list when a whole blood drive is necessary. It is recommended that a hard copy of Donor Database and deferral list be printed monthly (or at some regular interval) for use during Emergency Whole Blood Collection when computer assets are unavailable. Information in database must be kept confidential.

   NOTE: Ensure TMDS user is logged into TMDS under the correct blood facility account. For TMDS account guidance, contact the COCOM JBPO.

2. To enter demographic data into TMDS, go to the Manage Donation tab and select Donate Product. Enter the Donor SSN, first name, last name in appropriate fields and click NEXT.

3. In Demographic information area, enter donor's ABO/Rh, nationality and branch. Military unit and contact instructions may also be entered in the demographic information fields. Enter donor's redeployment date if known along with further contact information. In the Donation information area, enter the pre-screen date, document status of ASBP 572-EWB completion, donor's ABO/Rh and Donor Identification Number (DIN). Click ADD PRODUCT(S).

   Note*: If any of the TMDS auto-populated information fields in demographic information area is incorrect, contact the JBPO or TMDS Help Desk for guidance. TMDS contact information can be found on the TMDS log-in screen.*

   Note*: The Donation Location field information will be auto-populated within TMDS.*

4. In product description field, enter E9999V00 – PRE-SCREEN. In the expiration date field, enter date 90 days from today and click Add Product.

5. Verify donation ID, product description, product type, ABO/Rh and expiration date are correct, then click NEXT.

6. Carefully Re-verify all demographic data that populates on the screen, then click Confirm Donation. Prospective donor is now entered in TMDS.

7. From Manage Donation tab, select Update Donation. Enter donation ID number and click NEXT.

8. Enter ABO/Rh test result and date tested from Form 147 under Rapid Testing Results. In "Samples sent to" field, select BSD or unit from pull down menu and enter date samples were sent out from your facility. Now click Update Tests.

9. To register another donor, select Donate Product under Manage Donation tab and repeat process above.
10. Once pre-screen donations have been created utilizing the process above, a re-deployment date must be entered to ensure the active donor list will auto-update upon donor's exodus from theater. To accomplish this, select Manage Donor from beneath Manage Donor tab. Enter donor SSN and click Next. Select re-deployment date from the calendar tool in the "Update Re-deployment Date" field and click Update Donor. Once the displayed entry is confirmed to be correct, click Confirm Update. TMDS will now remove donor from active donor list on the re-deployment date that was entered.
11. BSD or designated unit will populate donor testing results and forward to submitting facility. Donor alerts will also be activated by BSD or unit, as necessary. This data, once populated, will be the basis by which potential donors will be deemed fully qualified for Fresh Whole Blood (FWB) donations, should the need for a Walking Blood Bank (WBB) arise at your facility.

NOTE: *In some cases, the submitting Role 2 or Role 3 may have to enter results into TMDS if not supported by a BSD.*

NOTE*: Investing time and care into building a donor pool will make performing whole blood drives easier and safer when the time comes. Your donor pool does not need to be enormous. 50 people covering most of the blood types (O, A, B) is ideal for most locations.*

Remember whole blood must be transfused group specific or from a group O/low titer donor.

6.0 Sources

- AABB Technical Manual, current edition.
- AABB Standards for Blood Banks and Transfusion Services, current edition.
- JTS Clinical Practice Guideline: Fresh Whole Blood (FWB) Transfusion
- Theater Medical Data Store (TMDS) System User's Manual, current edition.

7.0 Forms

- ASBP 572-EWB (Emergency Whole Blood)
- Form 147–Eldon Card ABO/Rh Typing Record
- Form 148–Pre-Screen/Whole Blood Sample Shipping Manifest

~ END ~

BLOOD DONOR PRE-SCREENING SOP ENCLOSURES (1)

ASBP 572: Emergency Whole Blood (front)

PRE-SCREEN / EMERGENCY WHOLE BLOOD DONATION RECORD

Form is only to be used for pre-screening or collecting donors in support of contingency / deployed operations.

DONATION IDENTIFICATION NUMBER (DIN)

(Use Donor SSN if ISBT # Not Available)

TODAY'S DATE	NAME (Last, First, Middle Initial)	RANK/RATE	USA USAF USN USMC CIV	SSN: / DoD ID:
UNIT	UNIT LOCATION (Base and State)	AOR BASE & TENT# (if deployed)	DOB (DDMMMYYYY)	SEX: M F / ABO/Rh (Blood Type)
CURRENT MAILING ADDRESS		EMAIL ADDRESS		BEST CONTACT PHONE NUMBER

Group A Questions (ALL DONORS Must Complete)

1	Have you read and do you understand the educational materials provided to you?	Y	N	5	Have you ever received money, drugs, or other payment for sex?	Y	N
2	Have you ever used needles to take drugs, steroids, or anything not prescribed by your doctor?	Y	N	6	Have you ever had cancer, heart problems, bleeding conditions, or lung disease?	Y	N
3	Have you taken any of the medications listed on the back of this form within the timeframes shown? If Yes, write medications here: _____	Y	N	7	Have you ever had hepatitis, or have you ever taken medication for treatment or exposure to hepatitis?	Y	N
4	Have you ever had a positive test for the HIV/AIDS virus?	Y	N	8	Have you ever had Malaria, Chagas or Babesiosis?	Y	N

Interviewer: Document review and eligibility below for walking blood bank (WBB) and/or low titer group O whole blood (LTOWB) donor program.

DONORS: If you are being **prescreened** for a WBB or LTOWB program, **STOP!!** Answer no more questions and sign at the bottom.
If you are here to donate a unit of blood, proceed to **Group B Supplemental Questions** and then sign at the bottom.

Group A responses acceptable (all no except Q1)? Y N ***Interviewer (initials):	All disease tests negative? Y N	Eligible for WBB? Y N	Titer Result (If group O): _____ (accept if < 256)	Eligible for LTOWB? Y N	Approving Official	Low Titer ID Issued? Y N NA

Comments:

Group B Supplemental Questions (Complete if Donating a Unit of Blood Today)

9	Are you feeling healthy and well today?	Y	N	18	In the past 12 months, have you lived with or had sex with a person who has hepatitis?	Y	N
10	Female donors: Have you ever been pregnant or are you pregnant now?	Y	N	19	In the past 12 months, have you had a transplant (such as organ, tissue, or bone marrow) or graft (such as bone or skin)?	Y	N
11	Female donors: Have you had sexual contact with a male who had sexual contact with another male in the past 12 months?	Y	N	20	In the past 12 months, have you had sexual contact with anyone who has HIV/AIDS or has had a positive test for the HIV/AIDS virus?	Y	N
12	Male donors: In the past 12 months, have you had sexual contact with another male?	Y	N	21	In the past 12 months, have you come into contact with someone else's blood?	Y	N
13	Are you currently taking malaria prophylaxis?	Y	N	22	In the past 12 months, have you had an accidental needle-stick?	Y	N
14	Are you currently taking any medications for an infection?	Y	N	23	In the past 12 months, have you had a blood transfusion?	Y	N
15	Have you had physical contact with someone who was vaccinated for smallpox in the past 8 weeks?	Y	N	24	In the past 12 months, have you had sexual contact with anyone who takes money or drugs or other payment for sex?	Y	N
16	In the past 48 hours, have you taken aspirin or anything that has aspirin in it?	Y	N	25	In the past 12 months, have you had or been treated for syphilis or gonorrhea?	Y	N
17	In the past 8 weeks, have you donated blood, platelets, or plasma?	Y	N	26	In the past 12 months, have you had sexual contact with anyone who has ever used needles to take drugs or steroids, or anything not prescribed by their doctor?	Y	N

Comments:

Today's Date:	Temperature: °F/°C (≤ 99.5°F/37.5°C)	Blood Pressure: / Systolic: 90-180 Diastolic: 50-100	Pulse: (50-100 bpm)	Hemoglobin: Male: ≥ 13.0 g/dL Female: >12.5 g/dL	Weight: (≥ 110 pounds/50kg)	Vital Signs Tech:

Does Donor Qualify? Y N ***Reviewer (initials):	Phlebotomist	Start Time	Stop Time (<15 mins)	Bag Manufacturer	Lot #	Expiration Date:	Segment #

I verify that I have answered the questions honestly, I had an opportunity to ask questions, I consent to donating blood today, and I feel my blood is safe to be transfused. If I am donating a unit of whole blood today, my blood will NOT be tested for viral diseases prior to transfusion due to the emergency situation. If for any reason I feel that my blood may not be safe, I will not donate today.

_____ _____

Donor's Signature *Date*

ASBP 572-EWB (Emergency Whole Blood), 5 Apr 2018

ASBP 572: Emergency Whole Blood (back)

DONOR EDUCATIONAL MATERIAL

Blood donation is a voluntary process requiring the collection of approximately 450-500 mL of blood. The usual collection time ranges from 5 to 10 minutes. Complications at the venipuncture site may include, but are not limited to: discomfort, bruising, swelling, or infection. Other complications could occur during or after your donation such as: fatigue, light-headedness, dizziness, nausea, vomiting, and/or fainting. On very rare occasions, a more severe reaction may occur.

MEDICATION LIST: Donors **SHOULD NOT** discontinue medications prescribed by their physician in order to donate blood. Certain medications in your system can cause harm to some patients if your blood is transfused. If your last dose of the following medications was taken within the timeframe listed, you should not donate today nor should you participate in a walking blood bank program because the medication has not cleared from your system.

Prescreen or Donating Blood Today:

Erivedge, Odomzo	Soriatane	Bovine Insulin, Human Growth Hormone, Tegison
2 years	3 years	**EVER** in your life

Donating Blood Today (must screen donor for drugs below AND list above if donating whole blood):

Eliquis, Feldene, Fragmin, Lovenox, Pradaxa, Savaysa, Xarelto		Arixtra, Brilinta, Coumadin, Effient, LMW Heparin, Jantoven, Warfilone	
2 days		7 days	
Plavix, Ticlid, Zontivity	Absorica, Accutane, Amnesteem, Claravis, Myorisan, Propecia, Proscar, Sotret, Zenatane	Avodart, Jalyn	Experimental Meds/Vaccines
14 days	1 month	6 months	1 year

Your signature on the other side of this form acknowledges that you understand the questions and this educational material and that you agree to not donate any blood products if you are at risk of transmitting Human Immunodeficiency Virus (HIV) or any other virus. We know that you would not donate unless you think your blood is safe. However, in order for us to assess all risks that may affect you or a patient receiving a transfusion, it is essential that you answer each question completely and accurately on the other side of this form. If you do not understand a question, ask a staff member. All information you provide is confidential. It is critical that you alert your unit provider or medic if any of your responses change or if you have any concerns about the safety of your blood. This will facilitate notification and follow up testing for the recipient if needed.

Your blood will be tested for several types of viral markers including Hepatitis B, Hepatitis C, HIV, syphilis and other infections. You will be notified about any positive test result which may disqualify you from donating in the future, and your name will be entered onto a list of permanently deferred donors. If testing does not occur (due to specimen acceptability) or if testing results are not clearly negative or positive, your name may be placed on a deferral list without you being informed until the results are further clarified. For active duty personnel and reservists, positive screening and confirmatory results will be forwarded to appropriate medical personnel for further evaluation and "fitness for duty" determination (if required).

HIGH RISK BEHAVIORS:

Certain diseases such as HIV/AIDS and hepatitis can be spread through sexual contact OR by sharing drug needles/syringes. These viruses can enter your blood stream and can be transmitted to another person who is transfused with your blood, plasma, or platelets. Sexual contact includes: Vaginal contact (contact between penis and vagina), oral sex (mouth or tongue on someone's vagina, penis, or anus), and/or anal sex (contact between penis and anus). **YOUR BLOOD CAN TRANSMIT DISEASES,** including HIV/AIDS, even if you feel well and all your tests are normal. This is because even the best tests cannot detect the virus for a period of time after you are infected.

DO NOT DONATE IF YOU:

- Have AIDS or have ever had a positive HIV test
- Have ever used needles to take any drugs not prescribed by your doctor
- Are a male who has had sexual contact with another male in the past 12 months
- Have ever taken money, drugs or other payment for sex
- Have had sexual contact in the past 12 months with anyone described above
- Have had syphilis or gonorrhea in the past 12 months
- Have been in juvenile detention, lockup, jail or prison for more than 72 consecutive hours in the past 12 months

DO NOT DONATE TO GET A TEST! If you think you may be at risk for HIV/AIDS or any other infection, do not donate simply to get a test. See your medical provider to obtain an HIV/AIDS test. The following symptoms can be present before an HIV test turns positive: fever, enlarged lymph glands, sore throat, and/or rash.

NOTIFY YOUR UNIT MEDIC OR UNIT PROVIDER IF:

- Anything changes that would cause a different response to a question
- If you think your blood may not be safe for another person to receive
- If you become sick within 14 days after donating a unit of blood

THANK YOU FOR DONATING BLOOD!

ASBP 572-EWB (Emergency Whole Blood), 5 Apr 2018

BLOOD DONOR PRE-SCREENING SOP ENCLOSURES (2)

Form 147 Eldon Card ABO/Rh Typing Record

Rapid ABO/RhTesting

	Eldon Card ABO/Rh Typing						
	Lot #						
Assigned Unit # / Pptient ID	Exp:					Tech Initials	
	Anti-A	Anti-B	Anti-D	Control	Interpretation		
	+ =	+ =	+ =	+ =			
	+ =	+ =	+ =	+ =			
	+ =	+ =	+ =	+ =

BLOOD DONOR PRE-SCREENING SOP ENCLOSURES (3)

Form 148–Pre-Screen/Whole Blood Sample Shipping Manifest

Prescreen/Whole Blood Sample Shipping Manifest

Blood Unit Number				Donation Date	Donor Name		Branch of Service	Nationality	SSN or ID #	DOB	FOB/Base	Unit	Donation Type (PS or FWB)
Facility ID (W0138)	YR	Unit Id #	ABO RH		Last	First							

Form 148
V. May 2012

APPENDIX C: EMERGENCY WHOLE BLOOD COLLECTION SOP

Emergency Whole Blood Collection Standard Operating Procedures

Purpose: This Standard Operating Procedure (SOP) accompanies the Whole Blood Transfusion Clinical Practice Guideline published by the Joint Trauma System, the DoD Center of Excellence for Trauma.

1.0 Materials and Equipment

Use the following materials and equipment as applicable

- Vitals Machine
- Blood Collection Beds
- Stethoscope
- Blood Pressure cuff
- Digital Thermometer and/or Tempadots
- Lancets
- POCT Hemoglobinometer
- Electronic table top scale (optional)
- Alcohol Pads
- Coban
- Blood Bags (CPDA-1 or CPD)

  ***NOTE**: If an additive solution (AS) bag is present with a multiple bag set-up, the AS SHALL NOT be added to the whole blood.*
- Blood Trip Scale with 585±2g trip counter-weight and QC weights or HemoFlow.
- Testing Collection Set: premade bags with sterile 4x4 gauze, Chloraprep, 2 red top tubes, 4 purple top tubes

  ***NOTE**: Gold/yellow top (serum separator) tubes may be substituted for red top tubes.*

  Note: Pearl top (plasma preparation) tubes may be substituted for 3 of the purple top tubes.
- ChloraPrep
- Adapter Luer
- ABO/Rh Testing Card (e.g., Eldon Military Kit or other FDA-approved device)
- 4x4 Gauze
- Adhesive Tape
- Hemostats
- Gloves
- Tourniquet
- Rapid HIV, Malaria, HBsAg, and HCV test kits
- Serological RPR kit
- Plastic Aliquot tubes/lids
- Parafilm
- Clinical Rotator
- Centrifuge
- Disposable Pipettes
- Scissors
- Strippers
- Metal Clips
- Biohazard Container/ Sharps Container
- Whole Blood ISBT Labels (100 number series)

OR

- **Fresh Whole Blood Collection Set**

(Donor & Recipient Modules) contains all items above (or alternatives), other than those shaded gray

1

2.0 Records/Forms

- Forms required:
- Modified ASBP 572-EWB
- Form 145
- Form 147
- Form 148
- Form 150A
- Form 150B
- Form 151 and SF 518 (as applicable)
- Theater Medical Data Store (TMDS)
- Blood Portal

3.0 Quality Control (QC)

- Perform QC on POCT Hemoglobinometer
- Perform QC on ABO/Rh Testing Card, RPR, HCV, HBsAg, HIV, and Malaria Kits (See package inserts and local SOPs for procedures.)
- Medical personnel should be trained by blood donor center/Blood Support Detachment or other qualified personnel.

4.0 Procedures

Perform the following steps when a physician requests whole blood units:

1. **Permission to Conduct the Blood Drives**

   - Notify Role 2/3 Commander, DCCS and Laboratory OIC/NCOIC that a physician is requesting whole blood for transfusion.
   - Once the Commander/DCCS/Medical OIC grants permission, initiate the emergency whole blood collection. Notify the Area Joint Blood Program Officer that facility is performing whole blood collection. Trained medical personnel should oversee the process.

2. **Donor Recruitment**

   - When emergency whole blood collections are required, donors will be selected in the following order, in descending priority:

     a. Donors who have been prescreened within the last 90 days with the full panel of FDA-licensed donor infectious disease tests and found to be negative for all tests.
     NOTE: *Any donor with a positive test result will not be listed as an approved, prescreened donor and must not be collected.*

     b. Donors who have been prescreened between 90 days and 365 days with the full panel of FDA-licensed donor infectious disease tests and found to be negative for all tests.

     c. Donors who report being repeat blood doors in the past and have not been deferred for transfusion-transmitted disease.

     d. Donors who have not been prescreened with FDA-licensed tests, nor have been blood donors in the past.

- To the maximum extent possible:
  a. Blood will only be collected from United States personnel to include military members, DoD civilians or contractors, or beneficiaries.
  b. Blood may be collected from pre-screened coalition partner forces if screening program has been reviewed by the JBPO and deemed acceptable by the COCOM Surgeon and the ASBP. Note, screening results must be available to the JBPO.
  c. On the day of donation, prospective donors will be screened for eligibility using approved donor history screening protocols and be tested for infectious diseases using ASBP-approved rapid screening tests. As much as possible, rapid screening tests should be performed before issuing the product.
- Low titer Group O Whole Blood (LTOWB) donors have been tested and found to have anti-A/anti-B antibody titers of <1:256 (recorded in TMDS). LTOWB collected from these donors may be given to a recipient of any ABO type during damage control resuscitation.
- Non-LTOWB FWB donors must be an ABO type-specific match to the casualty. If not matched, a fatal hemolytic reaction may occur. Casualty ABO/Rh type must be determined (by using rapid ABO/Rh card or laboratory testing) before conducting type-specific FWB collection.

3. **Pull a pre-screened donor list from TMDS: Manage Donor>View Donor List.**
4. **Select filters**
   a. Select filters for ABO/Rh of the potential whole blood recipient if using type-specific FWB, Screened (select ALL), Alert (select ALL), COCOM (select applicable).
   b. Highlight your facility in the Available Facilities tab and click Add.
   c. Once your facility appears in the Search Facility box, click Display Donor List.
   d. The potential donor list for the blood type required will now appear on the screen.

   ***NOTE**: If searching for LTOWB pre-screened donors, use same process above except select O pos and O neg in the ABO/Rh selection area.*
5. **Verify donor**

The donor ABO/Rh must be verified (by rapid ABO/Rh card or laboratory testing) prior to transfusion even if donor is in TMDS with pre-screening results.

5.0 Donor and Testing Area Preparation

1. Set up blood donor beds.
2. Perform QC on weighing device if available, (i.e., HemoFlow or Trip Scale).

   ***NOTE:** If no trip scale is available, see section below Whole Blood Collection: Set up the whole blood collection bag.*

3. Ensure the necessary equipment to perform donor screening, testing and collection are available. (See WBB Supply List with NSNs)

6.0 Perform Donor Screening

1. To the greatest extent possible, potential whole blood donors should be selected from among the pre-tested and qualified population documented in TMDS. This is the best practice to mitigate the risk to the recipient of Transfusion Transmitted Diseases (TTD) and hemolytic reactions.
2. Give donor ASBP 572-EWB and instruct donor to complete demographic information and to answer questionnaire by circling "Yes" or "No". While donor is completing questionnaire, screen for donor alerts and completed FDA test results in TMDS (deferrals).
3. Locate donor's name on the Donor List displayed in TMDS. To the left of their name, click View. If all TTD results are Negative (within last 90 days) and there are no Donor Alerts, then the Donor is deemed fully Pre- Screened/Tested. To minimize risk to the recipient, it is recommended that pre-tested population be exhausted prior to resorting to collections from the untested population.
4. A qualified interviewer will review the ASBP 572-EWB for completeness and donor suitability criteria following steps below.

   If/Then Scenarios

   IF: Responses for questions 1 and 9 are "Yes" AND Responses for questions 2-8 and 10-26 are "No"*
   THEN: Proceed to step 5 for donor temperature.

   IF: Response to question 1 or 9 is "No" AND/OR There are any "Yes" responses for questions 2-8 or 10-26*
   THEN: Document the reason for the "Yes" response (questions 2-8 or 10-26) or "No" response (questions 1 or 9). Defer the donor.

   ****NOTE**: For question 13, if the donor is required by the Chain of Command to take malaria prophylaxis due to deployed location, then response should be "Yes". If donor answers "No" despite being required to take prophylaxis, then donor should be deferred unless all other suitable donors are unavailable.*

5. Perform and record temperature on the ASBP 572-EWB.

   If/Then Scenarios

   IF: ≤99.5 ºF or 37.5 ºC
   Then: Proceed to the next step.
   IF: >99.5 ºF or 37.5 ºC
   Then Stop the donation process. The donor is "Ineligible" at this time.

6. Perform and record measurements of donor pulse and blood pressure on the ASBP 572-EWB.

   IF: Systolic BP is 90-180
   Diastolic BP is 50-100
   Pulse is 50-100 bpm

   THEN: Proceed to step 7 for donor hematocrit.

IF: Systolic BP is <90 or >180
Diastolic BP is<50 or >100
Pulse is <50 or >100
THEN: Stop the donation process. The donor is "Ineligible" at this time.

7. Perform and record hematocrit/hemoglobin results on ASBP 572-EWB, if possible.

If/Then Scenarios

IF: Male: ≥13.0 g/dL
Female: ≥12.5 g/dL
THEN: Proceed to next step.

IF: Male: <13.0 g/dL
Female: <12.5 g/dL
THEN: Defer donor and stop the donation process. The donor is "Ineligible" at this time.

8. Donor is physiologically acceptable to donate, have the donor sign the ASBP 572-EWB and proceed to next step.

9. A competent medical authority should review the ASBP 572-EWB to determine the eligibility of the donor.

IF/Then Scenarios
IF: Acceptable.
THEN: Donor is "Eligible," proceed to Step 10.

IF: Unacceptable.
THEN: Donor is "Ineligible," stop donation process and document deferral as appropriate in TMDS.

10. Issue blood bag and test collection set to donor. Label bag and ASBP 572-EWB with Whole Blood ISBT labels. Blood collection tubes (2 red top 4 purple top) should be labeled with the corresponding small ISBT labels (without barcode). See Illustration to the left. If no labels are available, bags and all samples should be labeled with donor's full name and DoD ID or Blood Bag Segment Number.

7.0 Whole Blood Collections

1. Seat donor in blood donor table or reclining chair. Ask the donor their name and verify donor demographic information is correct on the ASBP 572-EWB. Verify also that the labels on the blood bag, sample tubes, and ASBP 572-EWB correctly correspond to each other and the donor.

NOTE: *If a discrepancy is noted, STOP and correct before proceeding further.*

2. Apply the tourniquet to the arm that will be used for phlebotomy.
   - Have donor grip their hands or a squeezable object
   - Palpate the antecubital area of the arm in order to locate a suitable vein
   - Remove the tourniquet

Note: *The vein of choice must be large enough for venipuncture using a 16-gauge needle and straight enough to accommodate at least one-fourth of the needle length*

3. Utilizing ChloraPrep, remove applicator from package; do not touch applicator tip.

4. Holding sponge tip down, pinch barrel of applicator to release antiseptic and wet sponge tip by pressing and releasing the sponge against the treatment area until liquid is visible on the skin.

5. Use gentle back-and-forth strokes over the 3 inch treatment area for 30 seconds and then allow area to dry for 30 seconds. Do not blot or wipe away antiseptic.

   NOTE: *It is not necessary to use the entire amount of the solution in the applicator*

6. Set up the whole blood collection bag.

   - Ensure that the donor's ISBT Label or ID has been recorded in the Unit Number field on the CPD Whole Blood Collection bag if not previously performed.
   - Ensure date is recorded in the "Today's Date" field under the Group B questions.

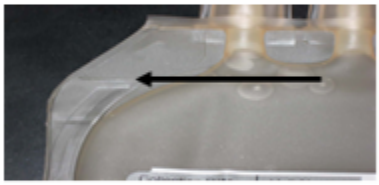
   Inspect the bag and tubing for cuts, kinks, discoloration or any kind of damage and discard bag if present.

7. Set-up trip scale (Manual or Electronic). Perform quality control, if possible, to obtain a counter-weight of 585 grams.

   NOTE: *If no trip scale is available, the Terumo Single Blood Bag (CPDA-1) can be filled with whole blood to the mark pictured below. It is however recommended that weight then be checked with table top scale (if available)*

   The target weight for 450 mL is 585 grams.

   Do not use if overfilled as blood clots may develop from an incorrect ratio of whole blood to anti-coagulant causing potential harm to the patient.



8. Using a hemostat, clamp tubing between the needle and the main bag. This will prevent air contamination of blood after the needle cover is removed. Place tape within reach for anchoring the needle during phlebotomy.

   NOTE: *Place a loose knot in the tubing approximately 6 inches from the needle prior to uncapping needle, if metal seal clips and hand crimpers are not available.*

9. Apply tourniquet with enough pressure. If using a blood pressure cuff adjust to approximately 40-60 mm Hg.

10. Twist off the needle cover and inspect the needle for barbs or other defects.

11. Pull the skin taut below the venipuncture site.

12. With the bevel up, hold the needle at the hub, at approximately a 30-45 degree angle and pierce the skin with a smooth, quick thrust at the selected point of entry.

13. When the bevel is completely under the skin, lower the angle of the needle to approximately 10º or less and, with a steady push, advance needle to penetrate the vein wall. Thread needle approximately ½ inch inside the vein to maintain a secure position and to lessen the chance of a clot forming.

14. Release the hemostat clamp on the collection bag tubing and observe the blood flow through the tubing and into the collection bag.

    IF/THEN Scenarios

    IF Blood flow is impeded
    THEN: Try adjusting the needle with least discomfort without hurting the donor.

    IF: Blood flow is still impeded
    THEN: Seek assistance from another phlebotomist before discontinuing the phlebotomy.

15. Fill sample tubes using tube adapter if available. After filling sample tubes, gently rock tubes to mix contents and verify once again that donation identification number on tubes corresponds to donation identification number on the collection bag and the ASBP 572-EWB.

    NOTE: *If no tube adapter available on whole blood bag tubing, fill sample tubes by performing a venipuncture phlebotomy on the arm not used for whole blood bag donation.*

16. Instruct donor to relax their grip and to rhythmically squeeze every 5 to 10 seconds, relaxing between squeezes.

17. Secure the needle to the donor's arm with tape, across the hub or on the tubing near the hub of the needle. This will optimize the positioning of the needle to prevent rotation of the needle or drag on the tubing, which may impede blood flow. An additional piece of tape may be placed across the tubing lower on the arm.

18. Partially reduce the pressure by loosening the tourniquet or blood pressure cuff to approximately 20-40 mm Hg. Mix blood bag several times during the collection to prevent clotting.

19. Cover the phlebotomy site with sterile gauze dressing, to keep the site clean and needle out of view. Lift the gauze occasionally to monitor for a hematoma.

20. If a hematoma is evident, remove tourniquet and needle from donor's arm and place sterile gauze square over the hematoma and apply firm digital pressure while donor's arm is held above the heart level.

21. Record the following in the appropriate blocks on the ASBP 572-EWB:

    - Time phlebotomy was started
    - Initials of the phlebotomist

22. Watch for the signal of a filled unit by monitoring for the completion indicator of the weighing device or visual reference point (see step 6), if not using a weighing device. Record stop time on the ASBP 572-EWB.

    NOTE: *A 10 inch piece of 5-50 cord/nylon cord may be used to check for unit fill. As bag fills, place cord around middle/center of bag and continue to monitor until both ends of the cord wrap around the bag and touch.*

23. Seal the tubing 1 to 2 inches below the "Y" segment of the tubing using a metal seal slip and a hand crimper (or pulling tight the loose knot in the tubing).

24. Grasp the tubing on the donor side of the seal and press to remove a portion of blood in the tubing. Crimp the tubing at this spot. Cut the tubing between the two seals.
25. Remove tourniquet or blood pressure cuff and tape strips from donor's arm.
26. Place the fingers of one hand gently over the sterile gauze. DO NOT APPLY PRESSURE OVER THE NEEDLE. With the other hand, smoothly and quickly withdraw the needle. Apply firm pressure to the phlebotomy site.
27. Instruct donor to apply firm pressure over the gauze. Encourage donor to maintain a relaxed elevated position, rather than tensing the muscle. This precaution will minimize the bleeding into the venipuncture area.
28. Secure the dressing with Coban or similar bandage wrap. Observe the donor for an appropriate length of time after the donation for any signs of an adverse event.
29. Discard the needle assembly into a sharps container.
30. Using a hand stripper/crimper, strip all blood from the tubing into the primary collection bag. This should be done ASAP after collection. (Stripping is pushing the blood in the tubing into the blood filled bag with the rollers on the stripper/crimper device)
31. Mix contents in the primary collection bag. DO NOT strip the tubing and allow tubing to refill without mixing. Release the stripper and allow the anti-coagulated blood to reenter the tubing. Perform this procedure three times.

8.0 Process Donor Units

1. Take donor unit and donor sample tubes (2 red top tubes, 4 purple top tubes) to processing area.
2. Strip donor units segment tubing three times and mix, so as to avoid the development of clots.
3. Perform ABO, Rh type utilizing ABO/Rh Testing Card and purple top tube. Record results on Form 147.
4. Write the donor blood type on the bag (ABO/Rh Testing Card) along with date, time and phlebotomist initials of collection.
5. If whole blood unit is drawn from a low titer donor, "Low Titer for Anti-A/Anti-B" should be written on the label or use a sticker with the same verbiage.
6. Write the expiration date of the unit on the label, which is 24 hours from collection if stored at room temperature. If placed into refrigerated storage within 8 hours of collection, the unit may be stored for 21 or 35 days depending on anticoagulant. JBPO approval is required for storage of whole blood unit for longer than 24 hours.

   NOTE: *CPDA-1 units have a 35 day expiration / CPD units have a 21 day expiration*
7. Create product in TMDS while Rapid Testing is being performed.

   NOTE: *Rapid tests should be performed and found to be negative prior to transfusion, to the greatest extent possible. In situations requiring whole blood, available blood component inventory should continue to be transfused in lieu of whole blood until rapid testing has been performed and found to be negative.*

9.0 Create Whole Blood Units in TMDS

1. From Manage Donation tab, select Donate Product.
2. Enter the Donor SSN, first name, last name in appropriate fields and click NEXT.
3. In Demographic information area, enter donor's ABO/Rh, nationality and branch. Military unit and contact instructions may also be entered in the demographic information fields. Enter donor's redeployment date if known along with further contact information. In the Donation information area, enter the pre-screen date, document status of ASBP 572-EWB completion, donor's ABO/Rh and Donor Identification Number (DIN). Click ADD PRODUCT(S).

   NOTE: *If any of the TMDS auto-populated information fields in demographic information area is incorrect, contact the JBPO or TMDS Help Desk for guidance. TMDS contact information can be found on the TMDS log-in screen.*

   NOTE: *The Donation Location field information will be auto-populated within TMDS.*
4. Enter product code E0053V00 for whole blood collected in CPDA-1 anticoagulant or E0009V00 for whole blood collected in CPD anticoagulant.
5. Enter the expiration date of the unit, which is 24 hours from collection if stored at room temperature. If placed into refrigerated storage within 8 hours of collection, the unit may be stored for 21 or 35 days depending on anticoagulant. JBPO approval is required for storage of whole blood unit for longer than 24 hours.

   NOTE: *CPDA-1 units have a 35 day expiration / CPD units have a 21 day expiration*
6. Click Add Product.
7. Verify donation ID, product description, product type, ABO/Rh and expiration date are correct, then click NEXT.
8. Re-verify all demographic and unit data then click Confirm Donation.
9. Repeat steps 1-8 for each product collected.

10.0 Pre-Transfusion Rapid Testing

1. Rapid tests should be performed and found to be negative prior to transfusion, to the greatest extent possible. In situations requiring whole blood, available blood component inventory should continue to be transfused in lieu of whole blood until rapid testing has been performed and found to be negative.
2. Centrifuge 2 Red Top and 3 Purple Top Tubes for 5 minutes at 4000 RPM.
3. Perform Rapid ABO/Rh using whole blood from 4th purple top tube and record results on Form 147.
4. Perform HBsAg, HCV, HIV, and Malaria using whole blood from 4th purple top tube. Perform RPR using serum from centrifuged red top tube. Testing should be performed IAW Test Kit package inserts and local SOP. Record reagent Name, Lot #, Exp Date, and Results on Form 145.
5. Upon completion of rapid tests with negative results, whole blood unit may be issued for transfusion.

6. When time allows, rapid test results need to be entered into TMDS. To do this click on Update Donation under the Manage Donation tab.

11.0 Issue and Manage Whole Blood Inventory

1. It is recommended that some sort of blood product issue document (ex., SF 518) be utilized to account for the issue of Whole Blood from the laboratory. WBB operations are at times chaotic and do not often allow for real-time updates of TMDS.
2. Provider requesting Fresh Whole Blood should sign Emergency Release Letter of understanding Form 150a or 150b as appropriate. Forms should be maintained in patient transfusion records.
3. Accurate dispositions of all Whole Blood units collected MUST be properly dispositioned in TMDS. Every unit must be created, transfused, expired or destroyed as appropriate.

12.0 Process Samples for Shipment and Testing

1. Label three aliquot (pour off) tubes with corresponding ISBT Labels with small barcodes. Position the ISBT label vertically toward the top of tube. Write "Serum" on one tube and "Plasma" on the other two tubes. If ISBT labels are not available utilize the Donor's DoD ID or other unique identifier as appropriate to label the pour off tubes.
2. Place plasma from 3 Purple Top tubes into the 2 aliquot tubes labeled "Plasma". *3ml sample requirement per aliquot.
3. Place serum from 2 Red Top tubes into the 1 aliquot tube marked as "Serum".

   Do not fill over ¾ full to allow for expansion from freezing
4. The seal of capped aliquot tubes should be reinforced with para-film wrap and placed into a biohazard shipping bag or rack. Repeat for each series
5. Record sample and donor demographic data on Form 148 (Shipping Manifest). Include a printed copy of manifest with shipment and e-mail to BSD or designated facility, if possible.
6. Form 151- Whole Blood Transfusion Checklist must be submitted with shipment for every unit of whole blood transfused.
7. Send copies of ASBP 572-EWB for each unit collection along with Form 145, Form 147 and Form 148 in a blood box (Collins Blood Box) with ice bag(s) to your respective blood detachment or designated receiving facility. E-mail a copy of manifest to BSD or designated facility, if possible, and call to alert about incoming shipment. Ensure originals of all forms remain at collecting location.
8. **Samples may be** frozen until they can be shipped to a designated laboratory to perform FDA-approved testing. Contact COCOM Joint Blood Program Office (JBPO) for guidance on specimen acceptability requirements. Depending on collecting unit/facility location and prior coordination, it may be possible to ship specimens directly to a testing or processing facility without performing the tube centrifugation and sample pour offs. Prior coordination MUST be made with COCOM JBPO or testing facility to ensure samples will remain viable if centrifugation step above will be skipped.
9. All donor tubes MUST be centrifuged and serum/plasma removed from RBCs within 72 hours of collection. The BSD or designated unit/facility will send all samples to designated laboratory for

FDA-approved testing. BSD or designated facility will enter results in TMDS and forward to submitting Role 2 or Role 3 upon completion. In some cases, the submitting Role 2 or Role 3 may have to enter results into TMDS if not supported by a BSD.

NOTE: *Testing for group O donors may include anti-A and anti-B titer testing. The titer testing must be coordinated with the testing facility prior to sample shipment.*

NOTE: *The results of this testing will be viewed as a pre-screen for donor's next donation.*

10. Any positive testing that is received by BSD or unit will be forwarded to Preventive Medicine Consultant or available Provider (MD, DO, PA, NP) to ensure proper donor care and follow-up is initiated. At no time will laboratory staff notify donors directly regarding positive testing results. JBPO will be notified of positive results to ensure recipient notification is completed for transfused units.

13.0 References

- AABB Technical Manual, current edition
- AABB Standards for Blood Banks and Transfusion Services, current edition.
- JTS Clinical Practice Guideline: Fresh Whole Blood (FWB) Transfusion
- Theater Medical Data Store (TMDS) System User's Manual, current edition.

14.0 Enclosures

- Form 145-A Rapid Testing Worksheet
- Form 150A–Emergency Release Letter of Understanding (tested)
- Form 150B–Emergency Release Letter of Understanding (un-tested)
- Form 151–Whole Blood Transfusion Checklist
- Standard Form 518-Blood or Blood Component Release
- WBB Supply List (with NSNs)

~END~

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (1)

Form 145: Rapid Testing Worksheet

Date:_____
Tech:_____

Disease Rapid Testing

	Rapid Tests												RPR	
	Malaria			HIV 1/2			HCV			HBsAg			Rotator (100 +/- 5 rpm):100	
	Lot #:			Lot #:			Lot #:			Lot #:			Lot #:	
Assigned Unit #	Exp:			Exp:			Exp:			Exp:			Exp:	
	Sample results		IQC OK?	Sample results		IQC OK?	Sample results		IQC OK?	Sample results		IQC OK?	"R" Reactive	"NR" Non-Reactive
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR
	R	NR		R	NR		R	NR		R	NR		R	NR

Supervisor Review: _____ Date: _____

QA/QC Review: _____ Date: _____

Form 145
V: 07 Sep 2015

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (2)

Form 150A: Emergency Release Letter of Understanding (tested)

Provider Letter of Understanding for Emergency (Non-FDA) Whole Blood Units

I understand that Emergency Whole Blood Units are NOT FDA approved and transfusion of these units may result in unintended disease and/or transfusion reactions. I accept full responsibility for the units and the consequences that may follow transfusion.

Print	Sign	Date
_____	_____	_____
Provider		

Form 150a

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (3)

Form 150B: Emergency Release Letter of Understanding (Untested)

Provider Letter of Understanding for Untested Emergency Whole Blood Units

I understand that these Emergency Whole Blood Units have not had complete Rapid Testing prior to transfusion and transfusion of these units may result in an increased risk of unintended disease and/or transfusion reactions. I accept full responsibility for the units and the consequences that may follow transfusion.

Print	Sign	Date
_____	_____	_____
Provider		

Form 150b

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (4)

Form 151: Whole Blood Transfusion Checklist

WHOLE BLOOD TRANSFUSION CHECKLIST

*COMPLETE THIS CHECKLIST FOR EACH UNIT **TRANSFUSED** POST EVENT*

LOCATION OF TRANSFUSION:	DATE:
WHOLE BLOOD UNIT #	

1. DONOR PRESCREENED FOR TRANSFUSION TRANSMITTED DISEASE (TTD) MARKERS WITH FDA APPROVED TESTS WITHIN LAST 90 DAYS?

YES_____ NO_____

2. DONORS SCREENED AT TIME OF COLLECTION USING RAPID TESTS FOR:

MALARIA YES_____ NO_____
HIV YES_____ NO_____
HBV YES_____ NO_____
HCV YES_____ NO_____
RPR YES_____ NO_____

3. RAPID TEST RESULTS AVAILABLE PRIOR TO PRODUCT RELEASE?

YES_____ NO_____

4. DONORS SCREENED USING **DD572** & CURRENT SOP ? YES_____ NO_____

5. BLOOD TUBES COLLECTED AT THE TIME OF COLLECTION FOR FOLLOW UP WITH FDA TTD TESTING YES_____ NO_____

6. INTERNATIONAL SOCIETY FOR BLOOD TRANSFUSION (ISBT) LABELS USED YES_____ NO_____

7. TUBES AND A COPY OF **DD572** FORWARDED TO BSD? YES_____ NO_____

8. UNIT ACCOUNTED FOR IN TMDS? YES_____ NO_____

9. WAS COMPONENT THERAPY AVAILABLE WHEN FWB WAS GIVEN YES_____NO_____

10. PLEASE PROVIDE ANY INFLUENCING FACTORS THAT PREVENTED YOU FROM FOLLOWING THE SOP FOR THIS TRANSFUSION EVENT (IF APPLICABLE):

_____

_____

_____

_____

INDIVIDUAL COMPLETING CHECKLIST

Print Name	**Signature**

This checklist is to be kept on file for a minimum of one (1) year. Forward a copy to BSD with corresponding samples for Every unit of Whole Blood transfused.

Form 151

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (5)

Standard Form 518-123: Blood or Blood Component Release

518-123 NSN 7540-00-634-4158

MEDICAL RECORD — **BLOOD OR BLOOD COMPONENT TRANSFUSION**

SECTION I - REQUISITION

COMPONENT REQUESTED *(Check one)*
- ☐ RED BLOOD CELLS
- ☐ FRESH FROZEN PLASMA
- ☐ PLATELETS *(Pool of _____ units)*
- ☐ CRYOPRECIPITATE *(Pool of _____ units)*
- ☐ Rh IMMUNE GLOBULIN
- ☐ OTHER *(Specify)* _____

VOLUME REQUESTED *(If applicable)*
_____ ML

REMARKS:

TYPE OF REQUEST *(Check ONLY if Red Blood Cell Products are requested.)*
- ☐ TYPE AND SCREEN
- ☐ CROSSMATCH

DATE REQUESTED

DATE AND HOUR REQUIRED

KNOWN ANTIBODY FORMATION/TRANSFUSION REACTION *(Specify)*

IF PATIENT IS FEMALE, IS THERE HISTORY OF:
RhIG TREATMENT? DATE GIVEN: _____
HEMOLYTIC DISEASE OF NEWBORN? _____

REQUESTING PHYSICIAN *(Print)*

DIAGNOSIS OR OPERATIVE PROCEDURE

I have collected a blood specimen on the below named patient, verified the name and ID No. of the patient and verified the specimen tube label to be correct.

SIGNATURE OF VERIFIER

DATE VERIFIED

TIME VERIFIED

SECTION II - PRE-TRANSFUSION TESTING

UNIT NO.	TRANSFUSION NO. / PATIENT NO.
DONOR	RECIPIENT
ABO	ABO
Rh	Rh

TEST INTERPRETATION

ANTIBODY SCREEN	CROSSMATCH

☐ CROSSMATCH NOT REQUIRED FOR THE COMPONENT REQUESTED — DATE

REMARKS:

PREVIOUS RECORD CHECK: ☐ RECORD ☐ NO RECORD

SIGNATURE OR PERSON PERFORMING TEST

SECTION III - RECORD OF TRANSFUSION

PRE-TRANSFUSION DATA

INSPECTED AND ISSUED BY *(Signature)*

AT *(Hour)* | ON *(Date)*

IDENTIFICATION

I have examined the Blood Component container label and this form and I find all information identifying the container with the intended recipient matches item by item. The recipient is the same person named on this Blood Component Transfusion Form and on the patient identification tag.

1st VERIFIER *(Signature)*

2nd VERIFIER *(Signature)*

PRE-TRANSFUSION

TEMP. | PULSE | BP

DATE OF TRANSFUSION | TIME STARTED

POST-TRANSFUSION DATA

AMOUNT GIVEN | TIME/DATE COMPLETED/INTERRUPTED

REACTION ☐ NONE ☐ SUSPECTED	TEMPERATURE	PULSE	BLOOD PRESSURE

If reaction is suspected – IMMEDIATELY:
1. Discontinue transfusion, treat shock if present, keep intravenous line open.
2. Notify Physician and Transfusion Service.
3. Follow Transfusion Reaction Procedures.
4. Do NOT discard unit. Return Blood Bag, Filter Set, and I.V. Solutions to the Blood Bank.

DESCRIPTION OF REACTION
- ☐ URTICARIA ☐ CHILL ☐ FEVER ☐ PAIN
- ☐ OTHER *(Specify)*

OTHER DIFFICULTIES *(Equipment, clots, etc.)*
☐ NO ☐ YES *(Specify)*

SIGNATURE OF PERSON NOTING ABOVE

PATIENT IDENTIFICATION – USE EMBOSSER (For typed or written entries give: Name–Last, first, middle; grade; rank; rate; hospital or medical facility) | SEX | WARD

BLOOD OR BLOOD COMPONENT TRANSFUSION
Medical Record

STANDARD FORM 518 (REV. 9-92)
Prescribed by GSA/ICMR, FIRMR (41 CFR) 201-9.202-1

Standard Form 518-123: Blood or Blood Component Release (instructions)

INSTRUCTIONS FOR NON SELF-EXPLANATORY ITEMS

SECTION I – REQUISITION

Component Requested

"Other (Specify)" – List any whole blood or blood product not on menu, i.e., washed RBC's deglycerolized RBC's, etc.

"Volume Requested (If applicable)" – Use only when different from standard amount, i.e., exchange transfusion 50 ml.

"Known Antibody Formation/Transfusion Reaction" – Check Medical Records. Annotate N/A if appropriate.

"If Patient is Female, Is There History Of" – Check medical records. Annotate N/A if appropriate.

SECTION II – PRE-TRANSFUSION TESTING

"Transfusion Number/Patient Number" – List either based on local procedures.

"Previous Record Check" – Current tests should be compared with prior records for ABO and Rh type, difficulty in blood typing, clinically significant unexpected antibodies, and severe adverse reactions.

"Test Interpretation" – Use the following standard notations. "NEG or "POS" for antibody screen block. "COMPAT" or "INCOMPAT" for crossmatch block.

SECTION III – RECORD OF TRANSFUSION

"Pre-Transfusion Data"

"Inspected and Issued by _____ at _____ on _____."
(Signature) (Hour) (Date)

This statement is to be completed by the issuing laboratory person once he/she has inspected the blood immediately before issue from the laboratory. The blood must not be abnormal in color or appearance or expired, and if any of these conditions exist the blood will not be used for transfusion.

"Signature" blank must contain the signature, as opposed to name, of issuing laboratory person.

"Hour" and "Date" are as of actual issue.

The issuing laboratory person will secure this form to the blood bag by string, rubberband, or tie knotted to the tag and the blood container before issuing the blood.

"Post-Transfusion Data" – Completed by transfusionist.

"Amount Given _____ ml" – Visual approximation.

"Description of Reaction" – Check appropriate reaction or describe "other" on separate sheet, if necessary, and attach to SF 518.

"Other Difficulties"– Check item or describe on separate sheet and attach to SF 518.

STANDARD FORM 518 BACK (REV. 9-92)

EMERGENCY WHOLE BLOOD COLLECTION SOP ENCLOSURES (6)

WBB and Pre-screen Supply List

WBB and Pre-Screen Supply List

Item	NSN
Fresh Whole Blood Collection Kit	6515-01-657-4750
Fresh Whole Blood Donor Set	6515-01-664-0306
Fresh Whole Blood Recipient Set	6515-01-663-9469
Purple top tubes	6640-01-378-0086
Gold top tubes	6640-01-585-5768
Pearl top tubes	6640-01-573-5282
Transfer Pipettes	6640-01-088-4246
Eldon Cards	6550-01-587-1889
Transfer pipettes	6640-01-088-4246
Malaria	6550-01-554-8731
HCV	6550-01-589-9845
HIV	6550-01-526-7424
HBsAg	6550-01-658-8877
RPR	6550-00-159-5011
Plastic tubes	6640-08-133-0372
Para film	6515-01-509-2783
Tape	6510-00-926-8882
Terumo Single Blood Bags	6515-01-480-2307
Chloraprep	6510-01-551-3496
Coban	6510-01-156-2366
Hand Stripper/Sealer/Cutter	6515-01-140-5267
Hand Sealer Clips	6515-01-070-1532
Scissors	6515-00-365-0640
Lancets	6515-01-367-8980
Sphygmomanometer	6515-01-039-4884
Stethescope	6515-00-935-4008
Blood Scale Hemoflow (optional)	6515-12-513-7010
Scale Stand (Optional)	6515-00-411-4375

APPENDIX D: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e. "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.

JOINT TRAUMA SYSTEM CLINICAL PRACTICE GUIDELINE (JTS CPG)

Acute Traumatic Wound Management in the Prolonged Field Care Setting (CPG ID: 62)

The intent of this guideline is to provide evidence- and experience-based solutions to those who manage both simple and complex wounds in an austere environment.

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INTRODUCTION

This Role 1, prolonged field care (PFC) guideline is intended for use after Tactical Combat Casualty Care (TCCC) guidelines when evacuation to higher level of care is not immediately possible. A provider must first be an expert in TCCC. The intent of this guideline is to provide evidence- and experience-based solutions to those who manage both simple and complex wounds in an austere environment. Emphasis is placed on the basics of wound care, using the tools most familiar to a Role 1 provider. Ideal hospital techniques are adapted to meet the PFC environment while still maintaining the highest standards of care possible.

SPECIAL CONSIDERATIONS IN AUSTERE ENVIRONMENT

Specific considerations for wound care in the PFC context: although all 10 of the PFC core capabilities should be implemented,[1] the following have areas of emphasis specific to longer-term wound care and management.

- **Physical examination:** Techniques specific to prolonged wound management include inspection of the wound and surrounding skin for evidence of necrosis or infection, passive and active range of motion to assess level of disability, ultrasound to assist in evaluating critical anatomy and/or guide regional anesthesia, distal pulse trending to assess for vascular compromise, and laboratory studies as an adjunct to determine the amount of blood loss or look for evidence of a developing infection.
- **Nursing:** Scheduled dressing changes are necessary to ensure proper wound healing and infection management. The bandage plan should include scheduled changes, materials to be used, as well as analgesia.
- **Surgical intervention:** Efforts are most likely geared toward irrigation and debridement. They should be scheduled and planned with evacuation timeline or inability to evacuate taken into consideration.
- **Telemedicine:** Should be initiated as early as possible so the consultant can properly guide the patient's management and monitor the patient's status. Photographs play a vital role in a consultant's ability to advise the Role 1 provider on wound care, especially in the assessment of viable tissue.

TYPES OF WOUNDS

- **Abrasion**: A wound created by scraping or wearing away of the skin. These are partial-thickness wounds.
- **Burn**: A wound created by thermal or chemical destruction of the skin and underlying tissues. These can be partial- or full-thickness wounds. Management of burn wounds is addressed in a separate guideline.
- **Puncture**: A wound caused by a narrow object and results in a relatively small skin opening relative to the depth.
- **Laceration**: A deep cut or tear in the skin.
- **Gunshot**: A wound caused by a bullet; involves a high transfer of energy and extensive damage to tissues.
- **Blast**: A complex wound that may involve penetrating fragments, extensive tissue damage or loss, and massive contamination with dirt and debris.
- **Crush injury**: A wound caused by blunt trauma and may include injury to skin, muscle, or bone.

The overall principles of wound management are the same for each type of wound. The size of the wound and the evacuation timeline, as well as resources available and level of training of the medical provider, will influence the wound management plan. In most cases, open wounds with contamination, devitalization, loss of tissue (skin, muscle, or bone), or infection will require a more complex treatment strategy because of the invasive nature of the wound, especially in the context of war wounds. Large abrasions still require careful cleansing and dressing with a high index of suspicion for skin infection. Careful evaluation of the wound should lead to development of a problem list in the event PFC will be required. The care provider should focus on anesthesia, debridement and irrigation, wound dressing, antimicrobial therapy, scheduled dressing changes, and pain control. In select cases, delayed primary closure (DPC) may be considered.

ANALGESIA

Goal: Irrigating, debriding, repairing, and bandaging wounds can be painful for the patient. Analgesia is often necessary to facilitate wound care and sedation may be required for more severe wounds.

- **Best**: Regional nerve block (for extremity wounds, ONLY if fully trained and equipped); and/or ketamine drip augmented with versed IV push as needed.
- **Better**: Local anesthetic and/or ketamine drip augmented with versed IV push as needed.
- **Minimum**: Local anesthetic and/or any pain medication.

    1. 1% or 2% lidocaine (with or without epinephrine)
    2. Oral (i.e., by mouth [PO]) acetaminophen and meloxicam
    3. PO acetaminophen/oxycodone (e.g., Percocet; Endo Pharmaceuticals, http://www.endo.com)
    4. Oral transmucosal fentanyl
    5. IV/IM ketamine
    6. IV morphine, hydromorphone, or fentanyl

Local anesthetic notes:

- For smaller wounds that require painful interventions, direct injection of local anesthetic into the wound margins with 1% or 2% lidocaine can provide enough analgesic effect for the patient's comfort.
- The maximum dose of lidocaine WITHOUT epinephrine is 3mg/kg (1% lidocaine has 10mg/mL and 2% lidocaine has 20mg/mL).
- The maximum dose of lidocaine WITH epinephrine is 7mg/kg (1% lidocaine has 10mg/mL and 2% lidocaine has 20mg/mL).
- Epinephrine injected with lidocaine has several properties that are advantageous: reduces bleeding, increases the duration of the local anesthetic effect by at least 50% depending on the site, and raises the maximum dose.
- Injection of epinephrine-containing anesthetics should be used with caution in the tip of the nose, ear, penis, fingers and toes, because of possible risk of ischemia.

- Buffering lidocaine with sodium bicarbonate using a 9:1 ratio (9mL lidocaine with 1mL bicarbonate), keeping the lidocaine at room temperature, and using smaller gauge needles can lessen the burning sensation associated with injection.
- Sodium bicarbonate buffers the acidity of local anesthetics, allowing for a more rapid analgesic onset.
- If properly trained and equipped with an ultrasound machine, the provider can perform ultrasound-guided regional blocks for those wounds in which local anesthesia will not manage the pain effectively during wound care. See Analgesia and Sedation CPG for PFC.
- For wounds that require the patient to be on a surgical plane, see Analgesia and Sedation CPG for PFC.

See the Analgesia and Sedation CPG for PFC for a more comprehensive summary.

IRRIGATION

Goal: Because war wounds are most often grossly contaminated, proper irrigation techniques should be implemented as early as possible after wounding to reduce the possibility of infection. Pressure, fluid choice, and fluid amount are the tenants of irrigation: the solution to pollution is dilution.

- **Best**: Irrigate wounds with Dakin's solution or sterile isotonic solution.
- **Better**: Irrigate wounds with clean, potable tap water.
- **Minimum**: Irrigate wounds with the cleanest water available (nonpotable water should be boiled for a minimum of 3 minutes and then cooled to body temperature).

Irrigation notes:

- Cleansing the entire patient (shower or cloth bath) will reduce the risk of infection.
- Bacterial loads drop significantly with increases in wound irrigation fluid volumes.[2]
- Evaluate the wound size and contamination level to determine the optimal amount of irrigation: 1–3L for small or clean wounds, 4–8L for intermediate or dirty wounds, and ≥9L for large or very dirty wounds.
- Dakin's solution (0.025%) may be used for irrigation of large, very dirty, or infected wounds to help treat wound infection and prevent fungal infection. A diluted concentration of one-tenth the strength of "half-strength" Dakin's solution has been shown to be toxic to microorganisms without damaging tissues. The recipe is given below.[3–5]

  Half-strength Dakin's Solution

  1. 1L water, sterile or boiled
  2. 5mL household bleach (5.25% hypochlorite solution, unscented)
  3. Sodium bicarbonate: 1.5mL (1/2 tsp) of baking soda or 4 ampules (200mL) of 8.5% sodium bicarbonate injection (preferred, but can leave out if not available)
  4. Once mixed, Dakin's solution can be stored. The half-strength solution should be diluted 1:10 with water for wound irrigation solution.

- Additives such as iodine, bacitracin, or alcohol are not associated with reduced infection.[6]
- Very high-pressure (>15 psi) irrigation is not associated with reduced infection and has been associated with tissue damage and injection of bacteria deeper into the tissues.[7] For smaller wounds, a large-bore catheter on the end of a syringe will provide high-pressure (6–15 psi) flow and is the ideal pressure for maintaining tissue viability and irrigation in a contaminated wound.[8] A 19-gauge catheter with a 35mL syringe will deliver approximately 8 psi. For moderate sized wounds, a bulb syringe or bottle with puncture holes in the top can be used for low pressure (<6 psi) irrigation. For large wounds, bags of IV fluids can be connected to IV tubing to facilitate large-volume irrigation or any large container may be used to pour water onto the wound while gently scrubbing the wound.[9]
- Debris made of wood, vegetative material, clothing, and any debris in the foot should be excised and/or removed if possible; however, foreign bodies penetrating into vital structures, including the eye, should be left in place until the patient can reach a surgical capability. Most retained metal fragments do not need to be removed, particularly if doing so creates additional tissue damage.

DEBRIDEMENT

Goal: Removal of devitalized tissue and debris reduces both infection and morbidity. Devitalized tissue acts as a medium for bacterial growth and inhibits leukocyte function. The goal is to remove this tissue while preserving as much perfused tissue as possible. A basic knowledge of debriding skills—cutting, clamping, grasping, ligation, and tying—allows the provider to effectively manage the balance between salvageable and unsalvageable tissue.

Identification of viable tissue may be challenging. Tissue that is clearly dead should be removed, whereas tissue of uncertain viability should be preserved and re-examined in 24–48 hours. Use the four Cs, along with clinical judgment, when excising muscle tissue: color, contraction, consistency, and circulation.

***Caution**: Debridement of large wounds or wounds associated with other injuries will result in significant blood loss. Be prepared to give blood transfusion.*

- **Best**: Use an assistant; remove nonviable tissue using sharp dissection (sterile scalpel or scissors) and control bleeding using tourniquet, topical hemostatic dressings, direct pressure, clamping, suture ligation, and/or electrocautery. Questionably viable tissue may be retained with repeat debridement once every 24–48 hours until arrival at surgical facility.[10]
- **Better**: Remove nonviable tissue using sharp dissection (sterile scalpel or scissors) and control bleeding using tourniquet, topical hemostatic dressings, direct pressure, clamping, and/or suture ligation. Repeat debridement or delayed primary closure in 3–5 days.
- **Minimum**: When unable to evacuate and resources for serial debridements are not available, remove all nonviable and questionably viable tissue, using sharp dissection (clean blade or scissors) and control bleeding with tourniquet and/or direct pressure. Leave clean dressing in place, then perform delayed primary closure in 4–7 days if no sign of infection.[11,12] See Appendix A for further details on the International Committee of the Red Cross (ICRC) method of wound care.

DEBRIDEMENT NOTES

Exposure

- Deeper wounds should be exposed through generous skin incisions in the long axis of the extremity.
- Avoid exposing major blood vessels, tendons, and nerves, unless they are injured.

Anatomic Considerations

- Review the anatomy of the injured body part before debridement. Extremity wounds are by far the most common and the need for reference anatomic diagrams should be anticipated.
- If a major blood vessel is injured, it will require ligation, repair, or shunting. In the extremity, ligation may result in amputation; however, vascular repair or shunting are advanced surgical skills.
- Damaged parts of tendons do not need much debridement and should be preserved when possible. Tendons may be repaired later as a delayed procedure.
- Damaged nerves should not be debrided. Some nerves may be repaired as a delayed procedure.
- Loose, unattached fragments of bone should be removed; however, any bone fragments still attached to muscle should be left in the wound. After debridement and dressing placement, a fractured extremity should be immobilized with a splint.
- After debridement, attempt to ensure that vital structures (i.e. blood vessels, nerves, tendons, bone) are covered with soft tissue. This may require partial wound closure or mobilization of soft tissue to cover the structure.
- Mangled extremities may require amputation. Amputation is best left to a surgical facility and the wound kept as clean as possible while awaiting evacuation. If evacuation is not possible, amputation may be necessary.
- An injured extremity may require fasciotomy. Be vigilant for signs of compartment syndrome.
- Wounds penetrating the chest cavity should not be probed and should be minimally debrided to avoid creating a pneumothorax. If a pneumothorax is present, a chest tube should be placed through a separate, clean skin incision.
- Wounds penetrating the abdominal cavity require abdominal exploration (i.e. laparotomy) if associated with hemodynamic instability or peritonitis. Otherwise, these wounds may be debrided and dressed as any other wound.
- Small wounds or puncture wounds can be managed using local anesthesia, washing (scrubbing) the wound with soap and water or disinfectant soap, irrigating, dressing, and then allowing the wound to close by secondary intent. Some minor excision of the wound edges may be indicated.
- Large wounds require careful attention to hemostasis, wound care, and consideration for repeat debridements or delayed closure.

Complex wounds are best managed with a telemedicine consultation. Photos or video of the wound should be transmitted.

Assessment of Tissue Viability

- Color is the least reliable trait for measuring tissue viability. Evaluate the tissue's color relative to similar tissue deemed viable. Nonviable tissue appears pale, bluish, gray, or black. Bruised tissue that is viable may also have a dark coloration.
- Contractility refers to the retraction of muscle tissue when tension is placed on it by grasping. Nonviable muscle tissue does not contract.
- Consistency evaluation involves comparing potentially dead tissue with live tissue in terms of texture, density, and rigidity. Viable tissue has elasticity and firmness, whereas nonviable tissue is friable and/or is in a state of liquefaction.
- Circulation may be the best indicator of salvageable tissue because any tissue that bleeds when very minor trauma is applied can almost always be judged as perfused and, therefore, viable.

Debridement Techniques

- **Cutting**: Meticulous sharp surgical technique using scalpel and scissors should be the starting point for almost all war wounds that involve penetrating foreign bodies. Typically, #10 or #15 scalpel blades (or #11, as an alternative) are used for the removal of skin tissue, and sharp scissors (e.g., Metzenbaum, Mayo) are used for the removal of deeper tissues below the dermis.
- **Grasping**: Forceps, such as the Adson, Rat Tooth, and DeBakey, are used for grasping and tissue manipulation to fully explore a wound.
- Ideally, equipment used for debridement should be sterile. However, if this is not available, disinfected or clean instruments will suffice (see Appendix B for nonstandard tool sterilization/disinfection).

Hemorrhage Control Techniques

Consideration for hemorrhage control should be given before starting debridement. For larger areas of debridement to an extremity, place a tourniquet before debridement. Elevate the extremity before tourniquet placement to facilitate venous return and reduce bleeding. Monitor the tourniquet times closely and attempt to keep the total tourniquet time <90 minutes.

- **Direct pressure** to a wound, preferably in combination with a hemostatic dressing, will stop most minor bleeding encountered during wound care.
- **Hemostatic dressings** should be applied along with direct pressure for a minimum of 3 minutes. At times, up to 10 minutes of direct pressure may be required.
    - **Basic hemostatic dressings** include Combat Gauze (Z-Medica; www.z-medica.com/healthcare), Celox gauze (Med-trade Products; http://www.celoxmedical.com), ChitoGauze (HemCon Medical Technologies, http://www.hemcon.com), and Surgicel (Johnson & Johnson, https://www.jnj.com).
    - **Advanced hemostatic agents** include FloSeal (Baxter Healthcare, http://www.floseal.com) and Evarrest (Johnson & Johnson, http://www.ethicon.com), among many others.
- **Clamping bleeding vessels** provides a temporary hemostatic maneuver. When applying a clamp, try to avoid crushing the surrounding tissues. The bleeding vessel can then be ligated and tied off. Clamps can be left on for an extended time, if necessary.

- **Ligatures/sutures** provide a definitive treatment. Use of a silk suture is generally sufficient, although other materials can be used as well (Appendix C). For smaller structures, either 3-0 or 4-0 suture is sufficient, whereas larger structures may require 0 or 2-0 suture.

- **Electrocautery** stops bleeding by burning the tissue. It is available as either a battery-powered, hand-held device or a larger portable device. This can be used to cauterize bleeding vessels up to 3mm in diameter. The bleeding site should be identified, the ends coapted between a pair of forceps or clamps, and electricity then applied. If the cautery device is used to "paint" the surface, this results in damage to surrounding tissues.

> ***Caution**: Aggressive debridement may cause uncontrollable bleeding. Do not debride an area larger than can be controlled with direct pressure or a tourniquet. Observe closely for bleeding for at least 1 hour after debridement.*

- **Debridement** is not a singular event.[10] War wounds often require multiple debridement procedures as the body physiologically responds and the wound evolves. When adequate resources are available, a patient's wound should be evaluated every 24 hours, or as often as the clinician deems necessary. When resources are very limited, the ICRC approach has been successfully used to limit interventions to an initial D&I with application of a bulky absorbent dressing.

DRESSINGS

Goal: Quality dressing application focuses on keeping wounds clean, absorbing drainage, debriding fibrinous exudate from the wound surface, and increasing the speed of healing.

Shallow Wounds or Abrasions

- **Best**: dressing tailored to the specific type of wound Abrasions: Apply antibiotic ointment (e.g., Bacitracin or Silvadene) to the skin, place a non-adherent dressing over the area (e.g., Adaptic [KCI, http://www.acelity.com] or Telfa [Medtronic, http://www.medtronic.com]), and cover with an absorbent gauze dressing (e.g., Kerlix [Medtronic]). This should be repeated daily.

  - Alternative: Silverlon (Argentum Medical, http://www.silverlon.com) can be applied directly to a clean wound and covered with a gauze dressing. Moisten outer gauze dressing with water or normal saline daily. Replace Silverlon every 3–5 days (can remove and clean with water and reuse for up to 5 days). The outer gauze can be changed as needed if it becomes saturated with exudate or otherwise dirty. If the patient develops any evidence of infection, the Silverlon must be removed and the wound inspected sooner than 3–5 days.

  - Puncture wounds or small open wounds: Apply an absorbent gauze dressing over the area and change as needed when it becomes saturated with exudate or otherwise dirty, or at least once every 24 hours.

  - Small, clean lacerations: may be sutured, or Dermabond (Johnson & Johnson, http://www.ethicon.com) can be applied to the skin to adhere the wound edges together. Ensure that the Dermabond is applied to the skin, not to the deeper tissues. If Dermabond is used to close the wound, this will also suffice as a dressing.

- **Better**: Apply any available sterile gauze dressing.

- **Minimum**: Apply any available clean dressing.

Deep or Large Open Wounds

- **Best**: Negative pressure wound therapy (NPWT)
  - Commercially available kits such as the KCI Wound vacuum-assisted closure (V.A.C. Therapy, KCI, http://www.kci-medical.com) device can be used to both cover the wound and promote wound healing.[13] For exposed soft tissue, the pressure is usually set at 75–125mmHg of continuous suction.
  - Field-expedient wound VAC devices can be improvised from gauze, Tegaderm or Ioban, and suction tubing hooked up to a suction device (Appendix D).
  - NPWT dressings are generally changed every 2–3 days. Although they can be left in place for a longer time, the degree of granulation that can occur after 3 days generally leads to some bleeding with their removal.
  - NPWT dressings placed over infected wounds should be changed daily, along with wound debridement and irrigation, until the infection is controlled.
- **Better**: Wet-to-dry dressing
  - Wet-to-dry dressings can be created using either a sterile isotonic fluid or clean water, if there is no sterile fluid available. A gauze dressing should be moistened (not soaked) and applied to all open, exposed tissues and loosely packed into the wound cavities. An absorbent gauze dressing or Army Battle Dressing pad is placed over top to absorb any extra fluids or exudate. This may be secured with tape or wrapped with a gauze bandage roll or elastic bandage.
  - Removal of dressings from a wound provides its own form of mechanical debridement; exudate adheres to the bandages and is then pulled from the wound during changing. Inspect old bandages during a dressing change for signs of infection by observing the color and odor of the exudate; the color should be off-white or slightly yellow, and the bandage should not smell sweet or foul. Do not moisten the gauze being removed to make the dressing change easier, otherwise the debridement effect will be lost.
  - Ideally, the dressing should be changed one or two times per day, unless the situation dictates a less frequent approach.
  - For wounds that are already draining heavily, a dry-to-wet dressing may be used instead.
- **Minimum**: Place a bulky dressing with dry gauze, absorbent padding, and elastic bandage; leave in place 4–7 days if wound is clean and without sign of infection. See Appendix A for further details on the ICRC method of wound care.

CLOSURE

Goal: In most cases, war wounds should be closed by a surgical facility, where infection can be more effectively mitigated and the wound can be explored more effectively. However, when appropriate, wound closure simplifies the overall management of the wound.

- Puncture wounds, in general, should not be primarily closed. Small wounds should be allowed to freely drain as needed and close by secondary intent. Larger puncture wounds may require debridement and irrigation, as described above.

- Lacerations with minimal tissue loss/destruction and minimal need for debridement can generally be primarily closed provided that the wound is clean, there is not significant tension with the closure, and there has been <12 hours from injury to closure (this can be extended to 24 hours for lacerations to the face or scalp).
- Lacerations that do not meet the above criteria can be considered for a DPC. These patients are provided 3–7 days of wound care to assure the wound is clean and without complications, and then is closed with either widely spaced sutures or staples.
- Undermine wound margins if needed to reverse the retracted and inverted edges, and relieve any tension to allow skin closure.
- Wounds with tissue loss or damage are generally not closed primarily. Instead, these wounds are treated with dressing changes and allowed to heal by secondary intent. However, there is occasionally a role for DPC in select wounds.
- When in doubt, it is better to leave a wound open and plan for healing by secondary intent.
- If a wound becomes infected after closure, it should be reopened and debrided to drain pus and remove infected, dead tissue.

> ***Caution:*** *Wound closure may speed healing; however, closure will also greatly increase the risk of infection. Only wounds that are very clean and have been well-debrided should be closed.*

INFECTION PREVENTION

Goal: Antimicrobial drug therapy is a critical complement to debridement and irrigation in the fight against infection. This includes prophylaxis against Clostridium tetani (the causal agent of tetanus), as appropriate.

- Guidance on specific antibacterial regimens can be found in the Joint Trauma System CPG Infection Control.
- In general, cefazolin 2g in 250 mL NS IV over 5 min every 8 hours for 24 hours is adequate for most dirty wounds of the head and neck, torso, and extremities.
- Oral antibiotics may be used: moxifloxacin 400mg PO once or clindamycin 300mg PO every 8 hours for 24 hours.
- Note: Moxifloxacin may be replaced with levofloxacin 750 mg PO daily to provide better coverage of bacteria found in wet terrain/ jungle environment.
- Ertapenem is commonly carried by Role 1 providers and gives broad-spectrum gram-positive, gram-negative, and anaerobic coverage. It is an acceptable choice when more-specific antibiotics are not available. Give 1g in 250 mL NS IV over 5 min (provides 24 hours of coverage).

If following the ICRC wound care method (Appendix A), continue antibiotics for 5 days or until DPC.

Prophylaxis against tetanus should be initiated, as appropriate, based upon the condition of the wound and the individual's immunization history.[14] (Appendix E).

INFECTION TREATMENT

Goal: If a wound develops signs of infection (e.g., increasing pain, erythema, purulent drainage) or the patient becomes systemically ill (e.g., fever, tachycardia, hypotension, lethargy, decreased mental status), wound infection must be identified and treated. Treat infected wounds with a combination of local wound care and systemic antibiotics.

- Remove all dressings and inspect wound.
- Wounds that have been closed must be reopened.
- Repeat wound debridement to drain pus and remove all dead, infected tissue. If necessary, extend the wound with an incision in the long axis of the extremity.
- Worst-case scenario may require amputation of an extremity to control life-threatening infection.
- Increase the frequency of dressing changes to once or twice daily.
- Continue antibiotics for 7–10 days, moxifloxacin 400mg PO daily, levofloxacin 750mg PO daily, or ertapenam 1g IV daily, or alternative broad-spectrum antibiotic as available (if possible, change antibiotic from prevention regimen).
- Wounds with known or suspected infections can be treated using Dakin's solution (dilute bleach) for irrigation and wet-to-dry dressing. This can be an effective adjunct, particularly for suspected fungal and Pseudomonal infections.[3,15]

Daily sugar or honey dressings for infected wounds may successfully treat infection in very austere settings.[12] This involves irrigating the wound with saline or the cleanest water available and then filling it with sugar or honey, which is left in place under a dry dressing, repeating every 24 hours.

Severe wound infection *is life threatening and may require aggressive debridement, up to and including amputation. Evacuate patient. If evacuation is not possible, obtain telemedicine consultation and initiate infection treatments above.*

SPECIAL CONSIDERATIONS

FACE AND SCALP

- These wounds rarely become infected because of the high blood flow of the face and scalp.
- Most face and scalp wounds can be closed after irrigation. Debridement should be minimized to reduce cosmetic deformity. If the patient will arrive at a surgical facility within 24 hours, it is better to defer wound closure.
- The clinician should take into consideration the low probability of infection when planning closure of a facial wound because of the poor cosmetic outcomes associated with delayed primary closure.
- When primary closure is acceptable, sutures should only remain in place for 4–5 days for the face and 7 days for the scalp.

OPEN GLOBE INJURY

- Apply an eye shield to prevent further damage.
- Do not place any type of dressing in contact with the globe or underneath the eye shield.
- Moxifloxacin 400mg PO daily to prevent endophthalmitis
- Ondansetron 4mg PO/IV every 4 hours as needed for associated nausea
- Pain control as needed (narcotics as well as ketamine are approved for use)
- Position the patient with the head elevated, if possible.
- Ultrasound evaluation is contraindicated when open globe injury is suspected.
- The best results are achieved if surgery occurs within 24 hours of injury.

ANIMAL BITES

- All animal bite treatments should begin with immediate, thorough cleaning of all wounds with soap and water.
- Most animal bites should be allowed to heal by secondary intent (especially puncture wounds).[16]
- Moxifloxacin 400mg PO daily OR Augmentin (amoxicillin/clavulanic acid; GlaxoSmithKline, http://us.gsk.com/) 875/125mg PO every 12 hours for 7 days are the best choices for most animal bites. Doxycycline (100mg PO twice a day) or clindamycin (300mg PO 3 times a day) with levofloxacin (750mg PO daily) are acceptable alternatives.
- Consider the need for rabies vaccination (Appendix E).

AQUATIC EXPOSURE

- Management of wounds exposed to fresh or salt water is unchanged; however, additional agents are occasionally required for adequate antimicrobial coverage.[17]
- Levofloxacin 750mg PO daily (second-line doxycycline 100mg PO twice daily) to cover for Aeromonas species and Vibrio species.

Given the risk of atypical infections, telemedicine consultation should be sought if the wound worsens.

CHRONIC NONHEALING WOUNDS

If a wound has not healed by 2 weeks, it is likely the result of underlying infection (consider osteomyelitis as a potential cause), inadequate tissue perfusion, or inadequate nutrition.[18] Often it is multifactorial and so more than one source needs to be addressed.

Consider telemedicine consultation if the wound is not healing.

- Packing and Planning Considerations. See Appendix F.
- Wound Management Summary Table. See Appendix G.

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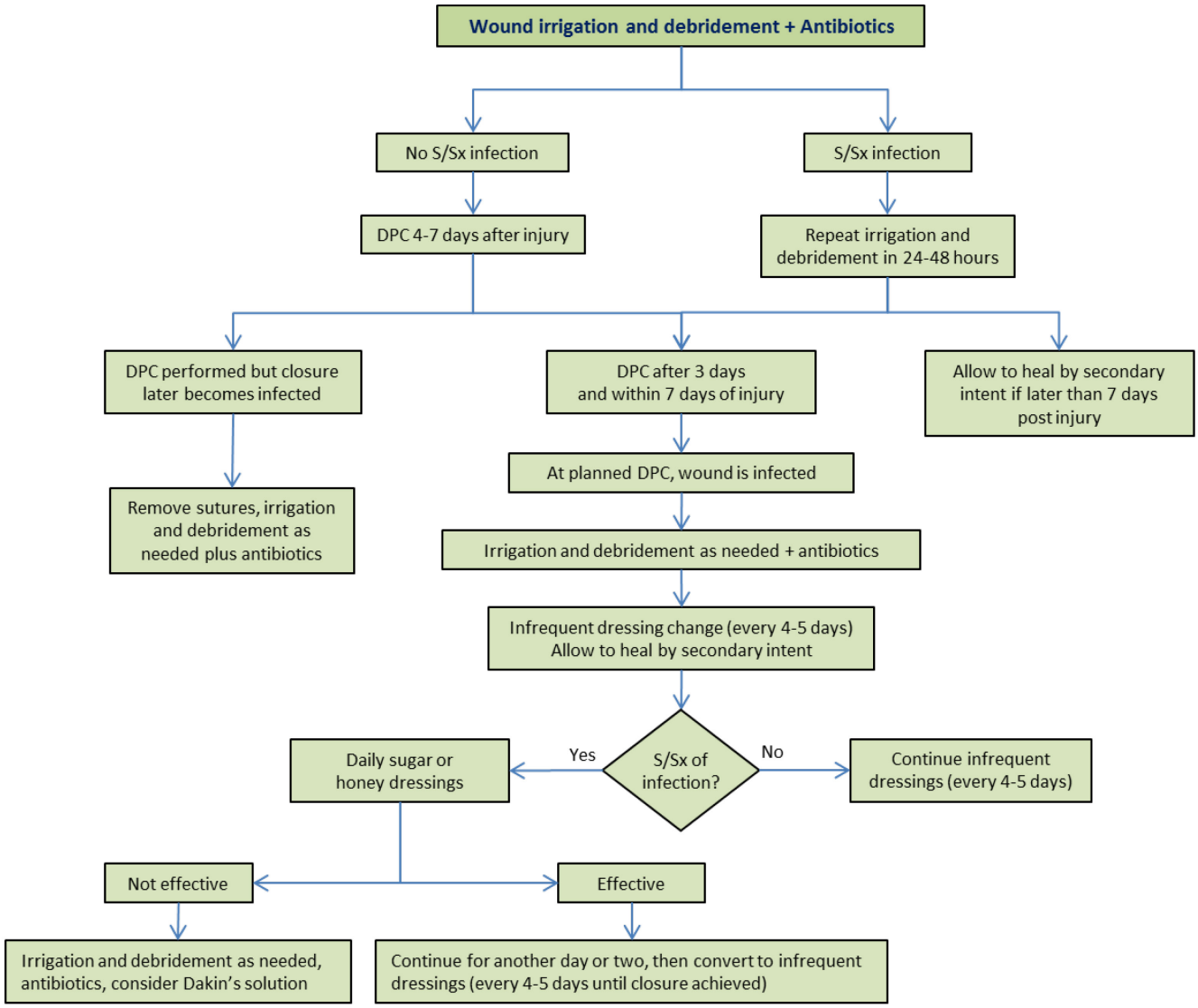
APPENDIX A : INTERNATIONAL COMMITTEE OF THE RED CROSS SURGICAL WOUND MANAGEMENT FLOW CHART


Wound irrigation and debridement + Antibiotics
No S/Sx infection
S/Sx infection
DPC 4-7 days after injury
Repeat irrigation and debridement in 24-48 hours
DPC performed but closure later becomes infected
DPC after 3 days and within 7 days of injury
Allow to heal by secondary intent if later than 7 days post injury
At planned DPC, wound is infected
Remove sutures, irrigation and debridement as needed plus antibiotics
Irrigation and debridement as needed + antibiotics
Infrequent dressing change (every 4-5 days) Allow to heal by secondary intent
Daily sugar or honey dressings
Yes
S/Sx of infection?
No
Continue infrequent dressings (every 4-5 days)
Not effective
Effective
Irrigation and debridement as needed, antibiotics, consider Dakin's solution
Continue for another day or two, then convert to infrequent dressings (every 4-5 days until closure achieved)

This pathway should be used when conserving resources is a top priority and when evacuation is not possible. DPC, delayed primary closure; S, sign; Sx, symptom.

Notes on wound care according to the ICRC method: The ICRC wound care methods are most applicable for management of war wounds in austere conditions and with limited resources that prohibit serial (follow-on) debridements with associated postoperative care:

1. Dirty environment
2. Limited supplies
3. Limited manpower
4. Limited time (mission dictated)
5. Wounds older than 24 hours
6. Inability to evacuate (includes host-nation patient care where care provided in the austere environment is the definitive level of care available)

Serial debridement every 24–48 hours is not possible in this environment. Therefore, the initial debridement must remove all tissue that is nonviable or questionably viable to remove dead tissue that may act as a culture medium. The wound is then managed with a bulky absorbent dressing that can stay in place for 4–7 days with a low likelihood of infection. Continue antibiotics for 5 days or until delayed primary closure.

Wounds that become infected or have exposed vital structures, such as blood vessels, nerves, or bone, should be treated with more frequent debridement and dressing changes.

After 4–7 days, remove the dressing and evaluate both the dressing and the wound using adequate pain control and sedation, as needed. The bandage and dressing should be dry, stained (greenish-black), and have an ammonia-like odor (good-bad odor), and the dressing should be adherent to the wound. The wound base should bleed slightly and the muscle should contract. Any small area of collagen that was not removed with the dressing can be scraped off with an instrument. This reveals a clean wound that is ready for closure.

If the wound is infected, the dressing may slide easily off the wound without resistance because there is a layer of pus between the dressing and the wound surface. The wound may contain areas of necrotic tissue and the surface of the wound is dull or greyish-red, or may give off the "bad-bad smell" of wound sepsis. Such an infected wound requires further excision and DPC is delayed or the wound is allowed to close by secondary intent. Closure by secondary intent may take several weeks. ICRC recommends a change of dry bulky gauze dressing and gentle washing with normal saline every 4–5 days for closure by secondary intent.

The ICRC dressing change algorithm for closure by secondary intent is as follows:

Question 1: Is the wound clean? **Yes:** infrequent (every 4–5 days) dressing with dry bulky gauze. **No:** continue
Question 2: Is there erythema and tenderness around the wound? **Yes**: antibiotics and continue **No**: continue
Question 3: Is there a large volume of exudate? **Yes:** daily sugar or honey dressings; this involves rinsing the wound with saline and then filling it with sugar or honey, which is left in place under a dry dressing. This is repeated after 24 hours. **No:** infrequent dressing with dry bulky gauze
Question 4: Has there been a response to sugar/honey dressings? **Yes:** Continue sugar/honey dressings or convert to infrequent dry bulky gauze. **No:** Consider antiseptic solution or further surgical debridement
If the wound exudate continues, consider exploring the wound surgically.

APPENDIX B: INSTRUMENT STERILIZATION (STANDARD AND NONSTANDARD)

DEFINITIONS

Cleaning: Removes dirt, debris, and biological material from surgical instruments

Disinfect: Cleaning with a disinfectant to destroy bacteria

Sterilize: Making free from bacteria or other living organisms

NOTES

- Cleaning, disinfecting, and sterilizing are the three levels of instrument care.
- Critical tools are those that make contact with open wounds, open vasculature, and/or organs. Semicritical tools are those that contact the mucosa, and noncritical tools are those that contact intact skin.
- Sterilization is the goal for any tools that will be used for surgical intervention; however, if life depends on it and sterilization is not an option; disinfection can be achieved using one of the options listed below as the "Better" option.
- The goal of sterilization is to eliminate the presence of bacteria, viruses, parasites, and particulates; bacterial spores are the most difficult to destroy.
- For all nonstandard sterilization techniques, gross contamination should be removed from all instruments/equipment by scrubbing with soap and water first.
- Chemical sterilization elements should never be combined.
- Steam with distilled water is the preferred sterilization technique.

BEST: Remove gross contamination, using soap and water, then sterilize by steam or dry heat using one of these techniques:

- Steam sterilization using one of the following techniques and the following temperatures: 121°C (250°F) for 30 minutes or 132°C (270°F) for 4 minutes
- Autoclave (portable or standard size) and distilled water
- Steam sterilization using the SF medical Tac-Set portable sterilizer pot (NSN: 6530-00-926-2022), according to the manufacturer's operating instructions:
    1. Remove the cover by loosening the wing nuts in a counterclockwise motion. Always undo two opposite wing nuts at a time.
    2. Lubricate the metal-to-metal seal where side wall and bevel meet on the inside of the sterilizer. Use petroleum jelly or mineral oil.
    3. Remove the aluminum inner container. Pour clean (preferably distilled) water into sterilizer to a depth of not less than three-fourths of an inch, but no more than 1 inch.
    4. Place inner container rack into inner container with the lip or edge side downward. Place articles to be sterilized on container rack. Only steam should make contact with articles. Replace packed inner container into sterilizer, ensuring the air exhaust tube channel is in position on the right side of the container when it is placed into the unit.
    5. Place sterilizer cover on unit, making sure that the index alignment arrow on the cover aligns with index line/arrow on the side of the bottom. Ensure that the flexible tube is inserted into the guide channel on the inside wall of the aluminum container. Tighten the wing nuts evenly, always tightening down two opposite nuts simultaneously to assure a proper seal.
    6. Place unit onto a heat source. Open the control valve by placing valve lever in an upright position. It is important that steam be permitted to escape vigorously for at least 7 minutes or until the flow of steam is continuous. Afterwards, close the control valve. When pressure gauge reaches 17–19 psi, reduce heat as necessary to maintain a constant pressure of 17–19 psi within the unit.
    7. The sterilization period begins when the pressure steam gauge needle registers in the green sterilization band shown on the face of the gauge (i.e., 17–21 psi). This should be no less than 35 minutes. Note: At altitudes higher than sea level, settings need to be adequately adjusted to compensate for the effect of altitude on water's boiling point. The manufacturer suggests increasing pressure by 0.5 psi for every 1,000 feet of elevation above sea level.
    8. At the end of the sterilization period, remove unit from heat source and move the lever on the control valve to an upright position to allow the steam to escape. With caution, loosen wing nuts and remove the cover to retrieve sterilized items.

DRY HEAT

- Dry heat may also be used to sterilize surgical instruments.
- Instruments can be wrapped in aluminum foil or placed in sterilization trays before putting them in the oven.
- Allow the instruments to cool to room temperature inside the oven before use or storage.
- Instruments can be heated to any of the following to be considered sterilized:
  - 180°C (356°F) for 30 minutes
  - 170°C (338°F) for 1 hour
  - 160°C (320°F) for 2 hours
  - 149°C (300°F) for 2.5 hours
  - 141°C (286°F) for 3 hours

BETTER: Remove gross contamination using soap and water, then sterilize with improvised autoclave or chemical disinfection.

- Improvised autoclave using a pressure cooker that can reach the steam sterilization temperatures listed above.
  - Place wire rack in the bottom to prevent the instruments from becoming submerged. Only steam should make contact with the instruments. Begin timing for sterilization once steam starts to vent from the pressure cooker.
  - Pressure cookers operate at various pressures and temperatures. Sterilization time of 60 minutes is recommended.
- Glutaraldehyde (Cidex©; Johnson & Johnson): Widely available and accepted as a high-quality disinfectant in healthcare facilities.
  - Can be used to sterilize aluminum, brass, copper, stainless steel, plastics, and elastomers.
  - Once the container is open, the chemical has a limited shelf life—a minimum of 14 days, usually 28–30 days; refer to the specific product's manual for the exact shelf life.
  - Test strips can indicate the efficacy of an opened container of glutaraldehyde.
  - Alkaline glutaraldehyde mixes are more effective than acidic glutaraldehyde mixes.
  - Items should be soaked for 60 minutes for maximum efficacy.
  - Long-term exposure can cause irritation to tissues; rinse tools before use.
- Formaldehyde: Prepare 5% formaldehyde solution.
  - Both metallic and plastic medical equipment can be sterilized using formaldehyde.
  - Wrap a 5mg tablet of formaldehyde in gauze and crush the tablet.
  - Place the gauze-wrapped tablet in 100mL of potable water (can be cold water).
  - This solution can be stored for up to 30 days without losing its potency.
  - Lower concentrations of formaldehyde can be used, but the amount of time the instruments are submerged in the solution needs to be increased to compensate for this change.
  - Clean the instruments with soap and water, and remove any blood and tissue.
  - Soak the instruments in the 5% formaldehyde solution for at least 1 hour but preferably for 12–24 hours.[19,20]
  - Duration should be closer to 24 hours if 1% formaldehyde solutions are used (i.e., 5mg tablet in 500mL of water).
  - The instruments and formaldehyde solution can be kept at room temperature.
  - Remove the instruments and rinse with water or saline before use.
- Alcohol: 60% to 90% minimum; tools need 3 hours of contact time. Consumable alcohol must be a minimum of 120 proof. This method is not sporicidal and, therefore, not recommended as a primary modality for surgical items.
- Sodium hypochlorite (household bleach)
  - This disinfectant is caustic to eyes, oropharynx, esophagus, and gastric tissue.
  - Undiluted (5.25%) sodium hypochlorite should be used to disinfect instruments categorized as critical.
  - Instruments should have a minimum contact time of 5 minutes.

MINIMUM: Remove gross contamination, using soap and water, then boil instruments in at least 100°C (212°F) water for at least 1 minute.

***NOTE*:** *This method does not sterilize instruments and should be used as a last resort for surgical instruments.*

APPENDIX C: SUTURE CHART

- When supplies are limited, any suture may be used for any purpose; however, as a general guideline, absorbable suture should be used to approximate tissues deep to the skin, silk may be used to ligate blood vessels, and a monofilament suture (nylon/Prolene; Johnson & Johnson) should be used for the skin.
- Most suturing/ligating can be accomplished with 2-0 sutures. Finer suture (3-0 or 4-0) may be used on the face for better cosmetic result. Heavier suture (0 or 1) may be used for DPC of larger wounds or for the scalp.
- Tapered needles are best for suturing soft-tissue layers; cutting needles are best for suturing skin; strait needles do not require a needle holder.
- Undesired tissue reactivity is greater with:
  - Multifilament (compared with monofilament)
  - Larger suture gauge
  - Natural material (compared with synthetic)
- Recommended multipurpose sutures: 2-0 Vicryl suture with CT-1 needle, 0 Prolene or Nylon with FSLX needle, 0 silk with strait needle.

Absorbable Sutures				
Suture	Effective wound support, days	Time to complete absorption, days	Comments	Usual indications
Surgical gut	8–9	30	Rarely used; high tissue reactivity	Approximate soft-tissue layers deep to the skin
Chromic gut	10–21	>90	Gut treated with chromium to decrease tissue reactivity and slow absorption	Approximate soft-tissue layers deep to the skin
Fast-absorbing gut	5–7	14–28	Gut treated with heat to speed absorption	Skin closure when suture removal will be difficult or impossible
Polyglactin (Vicryl)	21	90	Less reactive than gut; synthetic	Approximate soft-tissue layers deep to the skin
Vicryl Rapide (Johnson & Johnson)	10	42	Gamma-irradiated to speed absorption	Skin closure when suture removal will be difficult or impossible

Non Absorbable Sutures				
Suture	Tensile Strength	Tissue Reactivity	Comments	Usual Indications
Silk	Low	High	Multifilament, pliable	Ligate blood vessels
Nylon (e.g., Ethelon; Johnson & Johnson)	High	Low	Monofilament, stiff	Skin closure
Polypropylene (e.g., Prolene)	Moderate	Very Low	Monofilament, less knot security (may need extra knot)	Skin closure, repair blood vessels

Suture Removal Time Frames	
Body Part	Number of Days After Suturing
Face	4-5
Scalp	7
Chest, extremities	10-14
High tension areas, joint, back	14-21

APPENDIX D: FIELD-EXPEDIENT WOUND VACUUM-ASSISTED CLOSURE

1. Copious irrigation with debridement of necrotic tissue and removal of foreign debris.

2. Placement of gauze or reticulated sponge at base of wound.

3. Placement of suction tubing (e.g., Blake, Jackson-Pratt, nasogastric, red rubber with holes) that can be attached to a suction source.

4. Placement of additional layer of reticulated sponge or gauze over suction tubing to separate suction from occlusive layer.

5. Placement of occlusive impermeable dressing, such as Ioban or Tegaderm, over the gauze/sponge and suction tubing.

6. Connect to suction source.

APPENDIX E: TETANUS IMMUNIZATION CHART

(Special Operations Forces Medical Handbook; US Department of Defense; Washington, DC: Government Printing Office)

Tetanus Immunization Status	Minor Clean Wound	Major Clean Wound	Contaminated Wound (War Wounds)
Fully immunized recent Td booster	N/A	N/A	N/A
Fully immunized Td booster 5–10 years ago	N/A	Tdap	Tdap
Fully immunized, no booster for >10 years	Tdap	Tdap	Tdap
Unknown, none, or incomplete immunization	Tdap	Tdap and TIG (250U)	Tdap and TIG (500U)

N/A, not applicable; Td, tetanus and diphtheria; Tdap, tetanus-diphtheria-acellular pertussis; TIG, tetanus immune globulin.

***Note**: Tetanus vaccination of mother gives her protection and protects the newborn in the first few weeks of life.*

Rabies Postexposure Immunization[21]		
Animal Type	**Evaluation & Disposition of Animal**	**Recommendations for Prophylaxis**
Dogs, cats, ferrets	Healthy and available for 10-day observation	Do not start unless animal develops symptoms, then immediately begin HRIG + vaccine
	Rabid or suspected rabid	Immediate HRIG + vaccine
	Unknown (escaped)	Consult public health officials
Skunks, raccoons, bats, foxes, coyotes, most carnivores	Regard as rabid	Immediate vaccination
Livestock, horses, rodents, rabbits; includes hares, squirrels, hamsters, guinea pigs, gerbils, chipmunks, rats, mice, woodchucks	Consider case-by-case	Consult public health officials. Bites of squirrels, hamsters, guinea pigs, gerbils, chipmunks, rats, mice, other small rodents, rabbits, and hares almost never require postexposure immunization.
If Not Previously Vaccinated		
Treatment	**Regimen**	
Local wound cleaning	All post-exposure treatment should begin with immediate, thorough	
Human rabies immune globulin (HRIG)	20 units per kg body weight given once on day 0. If anatomically feasible, the full dose should be infiltrated around the wound(s), or the rest should be administered IM in the gluteal area. If the calculated dose of HIRG is insufficient to inject all the wounds, it should be diluted with normal saline to allow infiltration around additional wound areas. HRIG should not be administered in the same syringe or into the same anatomical site as vaccine, or more than 7 days after the initiation of vaccine. Because HRIG may partially suppress active production of antibody, no more than the recommended dose should be given.	
Vaccine	Human diploid cell vaccine (HDCV), rabies vaccine adsorbed (RVA), or purified chick embryo cell vaccine (PCECV) 1 mL IM (deltoid area), one each days 0, 3, 7, 14.	
If Previously Vaccinated		
HRIG	Do not give	
Vaccine	HDCV or PCECV 1mL IM (deltoid area), one each on days 0 and 3.	

APPENDIX F: PACKING AND PLANNING CONSIDERATIONS

- This list is not all encompassing.
- Quantities of items listed are highly mission variable and up to provider discretion.
- All efforts were made to list items in common use.

Instruments	Hemorrhage control
• Metzenbaum scissors • Mayo scissors • Rat Tooth/Adson/DeBakey forceps • Kelly, Mosquito, Hemostat forceps • Allis forceps • Needle drivers • #10/#11/#15 scalpels • Volkmann or Weitlaner retractors • Bovie pen	• Combat Gauze/ChitoGauze • C-A-T[b] tourniquet/SOF Tactical tourniquet, wide[c]/Esmarch bandage/ sphygmomanometer with Esmarch bandage
Meds	**General supplies**
• Bacitracin/Silvadene • 2% Lidocaine with/without epinephrine • 8.4% sodium bicarbonate • 0.5% tetracaine hydrochloride (eye drops) • IV ertapenem • IV cefazolin • Oral moxifloxacin 400mg or oral levofloxacin 750mg • (Note: levofloxacin is preferred in wet/jungle environment) • Oral clindamycin 300mg • Pain and sedation medications • NaCl (for irrigation)/potable water source • Sterile water	• Alcohol pads • Betadine swabs • 1mL, 5mL, 10mL, 35mL, 60mL syringes • 19g Catheter • 18g IV 1.5", 25g 1.5" hard needle • Irrigation bulb • Basin • Chux pads • Gloves of various sizes (small, medium, large) • IV tubing • Large-bore catheter • Constricting band • Saline lock • Suture/ligature (see Appendix A) • Skin stapler • Cotton tip applicators • Morgan lens • Sterile drapes or draping material that can be sterilized • Surgical masks • Surgical gowns • Sterile gloves • Ioban 2–23" × 23" • Tegaderm • Suction tubing • Suction device (SSCOR Quickdraw suction; TAC-SET)
Dressings	
• Kerlix • 6", 4" Ace wrap • Coban[a] • 3", 2", 1" medical tape • Telfa/Adaptic • Silverlon • Dermabond/superglue • Steristrips	

[a]3M, http://www.3m.com;

[b]Combat Application Tourniquet, Composite Resources, http://combattourniquet.com/;

[c]Tactical Medical Solutions, https://www.tacmedsolutions.com.

APPENDIX G: WOUND MANAGEMENT SUMMARY TABLE

Goals of Wound Care	
• Hemorrhage control • Minimize risk of infection • Promote optimal healing • Reduce discomfort • Minimize disability/loss of function associated with treatment • Implement definitive care when possible	
Types of Wounds	
• Abrasion • Burn • Puncture • Laceration	• Gunshot • Blast • Crush injury
Telemedicine	
• Large or complex wounds • Associated injury to bone, blood vessel, tendon, nerve • Penetrating chest or abdominal wound • Infected wounds • Chronic, nonhealing wounds	
Irrigation	
Best	Irrigate wounds with dilute Dakin's solution or sterile isotonic solution.
Better	Irrigate wounds with clean potable tap water.
Minimum	Irrigate wounds with the cleanest water available (nonpotable water should be boiled for a minimum of 3 minutes and then cooled to body temperature).
Debridement	
Best	Use an assistant, remove nonviable tissue using sharp dissection (sterile scalpel or scissors) and control bleeding using tourniquet, topical hemostatic dressings, direct pressure, clamping, suture ligation, and/or electrocautery. Questionably viable tissue may be retained with repeat debridement once every 24–48 hours until arrival at surgical facility.
Better	Remove nonviable tissue using sharp dissection, control bleeding using tourniquet, topical hemostatic dressings, direct pressure, clamping, and/or suture ligation. Repeat debridement or delayed primary closure in 3–5 days.
Minimum	When unable to evacuate and resources for serial debridement every 24–48 hours are not available, remove all nonviable and questionably viable tissue using sharp dissection (clean blade or scissors) and control bleeding with tourniquet and/or direct pressure. Leave clean dressing in place then delayed primary closure in 4–7 days if no sign of infection (ICRC wound care method).
Dressings – Shallow wounds or abrasions	
Best	• Abrasions: Apply antibiotic ointment (e.g., Bacitracin or Silvadene) to skin, place nonadherent dressing over the area (e.g., Adaptic or Telfa), cover with absorbent gauze dressing, repeat daily. Alternative: Apply Silverlon dressing to a clean wound, cover with gauze, moisten gauze daily. Replace Silverlon every 3–5 days. • Puncture wounds or small open wounds: Apply absorbent gauze dressing, change when saturated with exudate or otherwise dirty, or at least once every 24 hours. • Small, clean lacerations: suture or Dermabond
Better	Apply any available sterile gauze dressing.
Minimum	Apply any available clean dressing.

Dressings – Deep or large open wounds	
Best	NPWT ・Commercial available kits such as the KCI Wound VAC device can be used to both cover the wound and promote wound healing. ・Field expedient wound VAC devices can be improvised from absorbent gauze, Tegaderm or Ioban, and suction tubing hooked up to a suction device. ・Change NPWT dressings every 2–3 days. ・Change NPWT dressings placed over infected wounds, along with wound debridement and irrigation, daily.
Better	Wet-to-dry dressing ・Wet-to-dry dressings using sterile isotonic fluid or clean water. ・Change the dressing 1–2 times per day unless the situation dictates a less frequent approach. ・For wounds that are draining heavily, a dry-to-wet dressing may be used instead.
Minimum	Place a bulky dressing with dry gauze, absorbent padding, and elastic bandage; leave in place 4–7 days if wound is clean without sign of infection.
Infection prevention	
・Tetanus prophylaxis if immunization status unknown ・In addition to wound care, treat open wounds with antibiotics as soon as possible after injury and continue for 24 hours with one of the following antibiotics: ・Moxifloxacin 400mg PO × 1 dose or levofloxacin 750mg PO × 1 dose ***Note:*** levofloxacin is preferred in wet/jungle environment ・Clindamycin 300mg PO every 8 hours ・Cefazolin 2g IV every 8 hours ・Ertapenem 1g IV 1 dose ・If following the ICRC wound care method, continue antibiotics for 5 days or until delayed primary closure.	
Infection treatment	
・Remove all dressings and inspect wound. ・Wounds that have been closed must be reopened. ・Repeat wound debridement to drain pus and remove all dead, infected tissue. If necessary, extend the wound with an incision in the long axis of the extremity. ・Worst-case scenario may require amputation of an extremity to control life-threatening infection. ・Increase the frequency of dressing changes to once or twice daily. ・Continue antibiotics for 7–10 days, moxifloxacin 400 mg PO daily or levofloxacin 750mg PO daily or ertapenam 1g IV daily, or alternative broad-spectrum antibiotic as available. ・Use Dakin's solution for the wet-to-dry dressing, particularly for suspected fungal and pseudomonal infections. ・Daily sugar or honey dressings for infected wounds may successfully treat infection in very austere settings	

NPWT, negative pressure wound therapy; VAC, vacuum-assisted closure.

APPENDIX H: ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

PURPOSE

The purpose of this Appendix is to ensure an understanding of DoD policy and practice regarding inclusion in CPGs of "off-label" uses of U.S. Food and Drug Administration (FDA)–approved products. This applies to off-label uses with patients who are armed forces members.

BACKGROUND

Unapproved (i.e., "off-label") uses of FDA-approved products are extremely common in American medicine and are usually not subject to any special regulations. However, under Federal law, in some circumstances, unapproved uses of approved drugs are subject to FDA regulations governing "investigational new drugs." These circumstances include such uses as part of clinical trials, and in the military context, command required, unapproved uses. Some command requested unapproved uses may also be subject to special regulations.

ADDITIONAL INFORMATION REGARDING OFF-LABEL USES IN CPGS

The inclusion in CPGs of off-label uses is not a clinical trial, nor is it a command request or requirement. Further, it does not imply that the Military Health System requires that use by DoD health care practitioners or considers it to be the "standard of care." Rather, the inclusion in CPGs of off-label uses is to inform the clinical judgment of the responsible health care practitioner by providing information regarding potential risks and benefits of treatment alternatives. The decision is for the clinical judgment of the responsible health care practitioner within the practitioner-patient relationship.

ADDITIONAL PROCEDURES

Balanced Discussion

Consistent with this purpose, CPG discussions of off-label uses specifically state that they are uses not approved by the FDA. Further, such discussions are balanced in the presentation of appropriate clinical study data, including any such data that suggest caution in the use of the product and specifically including any FDA-issued warnings.

Quality Assurance Monitoring

With respect to such off-label uses, DoD procedure is to maintain a regular system of quality assurance monitoring of outcomes and known potential adverse events. For this reason, the importance of accurate clinical records is underscored.

Information to Patients

Good clinical practice includes the provision of appropriate information to patients. Each CPG discussing an unusual off-label use will address the issue of information to patients. When practicable, consideration will be given to including in an appendix an appropriate information sheet for distribution to patients, whether before or after use of the product. Information to patients should address in plain language: a) that the use is not approved by the FDA; b) the reasons why a DoD health care practitioner would decide to use the product for this purpose; and c) the potential risks associated with such use.